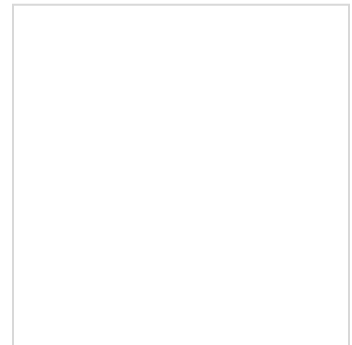
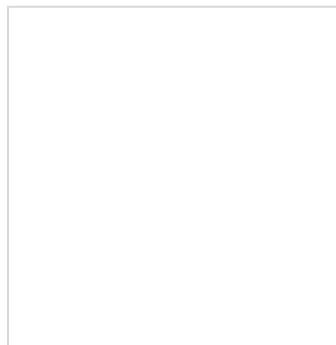


AFTON CENTRAL SCHOOL DISTRICT

Afton, New York

AFTON MAIN BUILDING 2025 CAPITAL PROJECT – PHASE 1
SED#: 08-01-01-04-0-001-019

HA PN: 2025-005P



VOLUME 3 ENGINEERING SPECIFICATIONS

BIDDING DOCUMENTS

“The design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Code, and the building standards of the New York State Education Department.”

November 3, 2025

**AFTON CENTRAL SCHOOL DISTRICT
MAIN BUILDING 2024 CAPITAL PROJECT – PHASE 1**

SED#: 08-01-01-04-0-001-019

**NOVEMBER 3, 2025
BIDDING DOCUMENTS**

HA PN: 2025-005P

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SECTION 21 00 00 - FIRE SUPPRESSION SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General Conditions, and other Division 01 Specification Sections apply to this Section.

1.2 REQUIREMENTS

- A. Hydraulic Calculations, Product Data, and Shop Drawings: Bear stamp of approval of authority having jurisdiction and the Owner's insurance underwriter prior to submittal to the Architect / Engineer.
- B. The conditions as defined in Common Work Results for Fire Suppression shall apply to all Division 21 specifications.
- C. This contractor shall carefully read the above-mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read or attend to any paragraph or items contained herein. Failure to bring any conflicts or discrepancies to the attention of the Architect/Engineer, in writing, prior to bid submittals shall not constitute grounds for extras and/or change orders. Costs resulting from this failure shall be bore by this contractor.

1.3 INTENT

- A. It is the intent of this specification and accompanying drawings to provide Fire Suppression systems, as specified herein and as shown on the contract drawings. The drawings show the general arrangement and extent of the work to be done. Exact location and arrangement of all components shall be determined as the work progresses. Plans are subject to such modification as may be necessary at the time of installation in order to meet construction conditions. Any adjustments shall be made by the Contractor, without extra charge.
- B. The Contractor shall include in his price a complete system. The project involves existing conditions, all of which may not be identified on the drawings. The Contractor shall assume that additional work will be needed to complete the project that is not indicated on the documents. The Contractor's price shall be all inclusive of this work. Additional time, material, and premium time may be required and determined during construction. Additional compensation after the bid will not be considered. The successful Contractor shall verify in his bid that he has included all necessary monies to complete the project. Premium time, including Saturday's, Sunday's and holidays may be needed to perform construction in existing areas that cannot be accessed during normal hours. This premium time shall be included in the final bid price. Exact room layouts may vary. Existing floor plans used were provided by Owner but some changes may have taken place in areas. Contractor to verify layouts and ceiling types. Shop drawings must be submitted to the Owner's Insurance Underwriter as well as Architect/Engineer.

1.4 WORK INCLUDED

- A. These specifications and accompanying drawings are intended to cover the furnishing by this Contractor of all labor, material and equipment of every kind necessary for the complete installation of the various systems and such other material and equipment as hereinafter specified and shall not be limited to the following:
1. Fire Department inlet assembly, complete with "Siamese" or Storz connection, with check valve. Coordinate with local fire chief for requirements.
 2. Provide complete manual dry-pipe standpipe system.
 3. All required flow and alarm devices. Wiring shall be by the Electrical Contractor.
 4. All required risers, valves, fire department connections, etc.
 5. Installation of piping mains in ceilings shall be coordinated with Architectural drawings and ceiling installation contractor.
 6. All pipe and fittings for the various systems.
 7. All necessary valves and shutoffs.
 8. All system drains to rainwater conductors, or the exterior.
 9. Provide O.S.&Y valve(s).
 10. Provide pipe insulation where indicated
 11. Provide painting on all pipe and equipment
 12. Provide fire suppression piping
 13. Provide pipe sleeves
 14. Provide testing of all equipment, piping systems etc.
 15. Provide valves for water-based fire suppression
 16. Provide hangers and supports for fire suppression piping and equipment
 17. Provide vibration and seismic controls for fire suppression piping and equipment
 18. Provide required drain/drain connections for the fire suppression system
 19. All painting of pipe and equipment in the Valve Rooms and other unoccupied areas, and all painting of piping in no ceiling areas as specified in Mechanical Requirements Section.
 20. Setting of all sleeves and inserts in place.
 21. Testing, adjusting and placing in service all systems and equipment installed.
 22. All fire protection equipment, piping, fittings, valves, etc. shall be commercial grade rated for 250 psi minimum (because of fire pump).
- B. The following items of work related to Fire Suppression will be performed by others as follows:
1. The General Contractor shall provide all foundations and pads for equipment, paint all piping in finished areas, provide all base flashing on roof, and build in all sleeves, unless otherwise noted.
 2. The General Contractor shall furnish and install all access panels and doors of sizes required.
 3. The General Contractor shall install all access panels furnished by the Fire Suppression Contractor.
 4. The Electrical Contractor shall do all power wiring for Fire Suppression equipment.

1.5 WORK AS A SUBCONTRACTOR

- A. When the Fire Suppression work is subcontracted, the exact scope of work may be limited or added to at the discretion of the General Contractor. A subcontractor shall, therefore, verify the extent of his work with the General Contractor.

1.6 RELATED WORK SPECIFIED ELSEWHERE

The following related work items are included in separate divisions and Sections as follows:

- A. General Requirements, Division 01.
- B. Site Work – Division 02.
- C. Concrete – Division 03.
- D. Roof Flashing – Division 07.
- E. Painting – Division 09.
- F. Basic Plumbing Requirements – Division 23.
- G. Fire Protection General Requirements – Division 21.
- H. Electrical – Division 26.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials and equipment shall be in accordance with the specifications as outlined in each specification section describing fire protection components, valves, piping, etc.
- B. All components shall be according to ASTM, ANSI, CISPI, NFPA and Code standards.
- C. Electrical equipment shall bear the underwriter label.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of components and systems shall be in accordance with 2020 Plumbing code of NYS with 2018 International Plumbing Code with amendments
- B. 2020 Building code of NYS with 2018 International Building Code with amendments

- C. 2020 Fire code of NYS with 2018 International Fire Code with amendments
- D. All the local Fire Chief, borough, city, town municipalities, etc. and any state or local codes having jurisdiction.

END OF SECTION 21 00 00

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the general requirements that apply to the Fire Suppression Contractor or Sub-Contractor.
- B. The following work is specified under other Divisions, unless otherwise noted or specified hereinafter:
 - 1. Painting except as herein specified, Division 09.
 - 2. Electrical Power, Division 26.
 - 3. Installation of starters, contractors, thermal overload switches and remote push buttons, Division 26.

1.3 INTENT

- A. Requirements specified herein shall govern applicable portions of Fire Suppression whether so stated therein or not.
- B. It is the intent of this specification and accompanying drawings to describe and indicate the general manufacture, erection and installation of the equipment and connection to same specified herein and shown on the drawings. It is not intended that the specifications and drawings describe and indicate each piece of equipment required for installation, for where items are intended or required for satisfactory installation and are considered to be the accepted practice of the trade, they shall be considered to be both specified and indicated. Drawings are diagrammatic in nature; for piping systems; provide all tees, elbows and swing joints as required for hookup branch piping as required for this work whether they are indicated on the drawings or not.
- C. The Contractor shall include in his price a complete system. The project involves existing conditions, all of which may not be identified on the drawings. The Contractor shall assume that additional work will be needed to complete the project that is not indicated on the documents. The Contractor's price shall be all inclusive of this work. Additional time, material, and premium time may be required and determined during construction. Additional compensation after the bid will not be considered. The successful Contractor shall verify in his bid that he has included all necessary monies to complete the project. Premium time, including Saturday's, Sunday's and holidays may be needed to perform construction in existing areas that cannot be accessed during normal hours. This premium time shall be included in the final bid

price. Exact room layouts may vary. Existing floor plans used were provided by owner but some changes may have taken place in areas. Contractor to verify layouts and ceiling types. Shop drawings must be submitted to Architect/Engineer.

- D. It shall be understood that the Contractor as hereinafter mentioned shall be the Fire Suppression Contractor unless specifically noted otherwise.
- E. The Contractor shall furnish all plant, labor and material necessary for the complete and satisfactory installation of all Fire Suppression work for this contract.
- F. The Contractor shall assume the entire responsibility for the materials, workmanship and satisfactory operation of the various fire suppression systems, and other work as specified herein and/or as shown on the drawings.
- G. The Contractor shall schedule and coordinate all work in close cooperation with all trades working on this project.
- H. All drawings and portions of the drawings, all floor plans, risers, details, schematics and specifications indicated shall apply and are part of the fire suppression contract.
- I. Any discrepancy or conflict noted between or within the above referenced documents shall be brought to the attention of the Architect/Engineer, in writing, a minimum of three (3) days prior to submittal of bids. The Architect/Engineer shall resolve issues prior to bid submittals.
- J. This Contractor shall carefully read the above mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read, or attend to, any paragraph or items contained therein. Failure to bring any conflicts or discrepancies to the attention of the Architect/Engineer, in writing, prior to bid submittals shall not constitute grounds for extras and/or change orders. Costs resultant from this failure shall be borne by this Contractor.

1.4 DEFINITIONS

- A. Following definition of terms and expressions used in this section are in addition to listing given in Supplementary Conditions:
 - 1. "Provide" shall mean "furnish and install" unless otherwise indicated.
 - 2. "Herein" shall mean the contents of a particular section where this term appears.
 - 3. "Indicated" shall mean "Indicated on contract drawings".
 - 4. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 5. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 - 6. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions.
 - 7. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in shafts.
 - 8. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

9. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic
 - b. CPVC: Chlorinated polyvinyl chloride plastic
 - c. NP: Nylon plastic
 - d. PE: Polyethylene plastic
 - e. PVC: Polyvinyl chloride plastic
10. The following are industry abbreviations for rubber materials:
 - a. CR: Chlorosulfonated polyethylene synthetic rubber
 - b. EPDM: Ethylene propylene diene terpolymer rubber
11. For additional abbreviations see the Abbreviations and Symbols Drawings.

1.5 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall be responsible for establishing grades and elevations, and checking of all interferences, and shall verify all dimensions and locations in the field.
- B. Contract drawings for fire suppression work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, ducts, piping and approximate sizes and locations of equipment outlets. Contractor shall follow these drawings in layout of their work, consult general construction, structural, HVAC, plumbing and electrical drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed.
- C. The Contractor shall verify with the A/E before bidding any item of piping or piping arrangement which may be incomplete, incorrect or indefinite. After contract is let, the A/E's decision shall be final.
- D. All trades shall cooperate and confer with each other as to locations of their materials and equipment before erecting work, so as to avoid interference as much as possible, and in such a manner that will in no way retard progress of construction. In instances where interferences develop, the contractor shall relocate the work as required by the A/E regardless of which work was installed first.
- E. Where job conditions require reasonable changes to indicated locations and arrangement, make such changes without extra cost to Owner and as approved by the A/E. This is not to be construed to permit redesigning of the various systems.
- F. Additional and supplementary drawings may, from time to time, be furnished, and the same, when made, are to constitute a part of the original contract. These drawings will be made to clarify the contract drawings and will not depart materially therefrom.
- G. The A/E specifically reserves the right, up to the time of roughing-in, to exactly define the position of the equipment to be installed and connected to and arrangement of these connections.

- H. Special attention is called to the contract drawings and specifications involving general construction, electrical work and details thereon. Bidders are notified to carefully scrutinize these documents for the details affecting the performance of the fire suppression work.

1.6 SCHEDULE OF WORK

- A. The Contractor shall schedule all of his work to conform to the Job Progress Schedule as submitted by the General Contractor or Construction Manager, and approved by the A/E.

1.7 PREMIUM TIME WORK

- A. The following work shall be performed at night or weekends other than holiday weekends, as directed and coordinated with the Owner:
1. Tie connections to all existing systems.
 2. All work in the existing building finished space.

1.8 RELATED WORK SPECIFIED ELSEWHERE

- A. The following related work items are included in separate divisions as follows:
1. General Requirements – Division 01
 2. Site Work – Division 02
 3. Concrete – Division 03
 4. Roofing Flashing – Division 07
 5. Painting – Division 09
 6. HVAC – Division 23
 7. Plumbing – Division 22
 8. Electrical – Division 26
- B. The following items of work related to fire suppression will be performed by others as follows:
1. All utilities for the building, including fire service piping to points indicated will be by Plumbing Contractor / Site Contractor.
 2. The General Contractor shall provide all foundations and pads for equipment, paint all piping in finished areas, provide all base flashing on roof, and build in all sleeves, unless otherwise noted.
 3. The Electrical Contractor shall do all wiring for fire suppression equipment unless otherwise noted.
 4. The General Contractor shall install all access panels furnished by the Fire Suppression Contractor.
 5. The Electrical Contractor shall furnish and install the emergency generator.

1.9 WORK AS A SUBCONTRACTOR

- A. When the fire suppression work is subcontracted, the exact scope of work may be limited or added to at the discretion of the General Contractor. A subcontractor shall, therefore, verify the extent of his work with the General Contractor.

1.10 INTERFERENCE WITH THE OWNER'S NORMAL OPERATION

- A. All work shall be performed in such a manner as not to interfere with the normal work operations in adjacent spaces or buildings.
- B. In no way shall the Contractor:
 - 1. Block or restrict the means of egress for adjacent spaces.
 - 2. Decrease the fire rating of walls, partitions, ceilings, doors or combination thereof of adjacent spaces or of means of egress.
 - 3. Interrupt safety systems or in any way adversely affect the safety of people or materials in adjacent spaces.
- C. The Contractor shall provide acoustical isolation of the work area via temporary doors, partitions, etc., adequate to allow normal work functions.
- D. The Contractor shall provide exhaust fans, dust proof temporary partitions and any containment measure required to prevent dirt, dust, or fumes from reaching adjacent work spaces.
- E. All personal traffic and material delivery shall be routed so as to absolutely minimize travel through adjacent work area.

1.11 VISIT TO SITE

- A. The Contractor shall visit the site and thoroughly acquaint himself with all existing conditions relative to type and source of service available. He shall verify location and extent of these services and consider routing, interferences and excavation required by the contract and any and all other difficulties that may be encountered.
- B. Submission of a proposal shall be construed as evidence that such an examination has been made.
- C. Failure to visit the site shall not constitute sufficient reason to warrant claims for extra monies for difficulties not apparent in the contract documents.

1.12 MANNING THE PROJECT

- A. The Contractor shall, upon initiation of construction, keep a suitable force of men on the site at all times in order to place all sleeves, inserts, equipment and provide all other openings as are required for the satisfactory installation of equipment.

1.13 FEES AND PERMITS

- A. The Contractor shall secure all permits and pay all fees, required by local and state governing bodies, necessary to complete his phase of the construction. Failure to investigate all applicable payments before the bid submission shall not constitute grounds for additional monies from the Owner. The Owner shall be furnished with all certificates of approval.
- B. The Contractor shall provide insurance and bonding as required by the Building Owner or as stated in the General Conditions.

1.14 CODES AND STANDARDS

- A. The design, construction and installation of all materials and equipment shall be in compliance with the latest edition of all national, state and local codes or standards.
- B. The codes and standards referred to are minimum standards. Where the requirements of these specifications and the accompanying drawings exceed those of the codes and standards, the drawings and specifications shall be followed.
- C. Coordinate with owner and site for all insurance underwriter's standards and practices. Follow all standards even if they exceed code requirements.

1.15 BASIS OF DESIGN

- A. The layout is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements and service connections required for these particular items have been considered in making the layout. The contractor may use the equipment of any manufacturer whose name is approved for substitution on that item of equipment after it is ascertained that all provisions of MATERIAL SUBSTITUTIONS will be complied with and that all required service connections will be made at no additional cost to the Owner.
- B. Except where dimensions are shown, the drawings are diagrammatic and shall not be scaled. Exact location of fixtures, apparatus, duct work and piping shall be determined by dimensions on the site. Contractor shall refer to architectural plans and details for exact dimensions.
- C. The drawings indicate the locations of apparatus, fixtures, and piping shall be followed as closely as possible. If before the installation it is found necessary to change the location to accommodate conditions at the building, such changes shall be made at no additional cost to the Owner, and as approved by the Architect/Engineer.
- D. Equipment requiring operation, service or maintenance during the life of the system shall be made easily accessible.
- E. Piping shall not be run within 42" of switchboards, panelboards or motor control centers.
- F. Use of open-flame devices in work shall be accompanied by fire extinguishing apparatus within 25 feet of work location. Provide Fire Watch review of work in stated intervals during each shift.

1.16 QUALITY OF MATERIALS

- A. Where a specific model and manufacturer of equipment is specified, the Contractor shall provide what is specified without substitution. Where specified as "or approved equal", the Contractor may substitute equipment except that the burden is upon the Bidder to prove such equality. If the Bidder elects to prove such equality, he must request the Architect's approval in writing to substitute such item for the specified item, stating the cost difference involved with supporting data, and samples, if required, to permit a fair evaluation of the proposed substitute with respect to quality, serviceability, warranty and cost.
- B. Where a specific model of equipment is specified along with an approved equal manufacturer, no substitution will be allowed. The Contractor shall submit one of the manufacturers listed.
- C. Final approval of competitive equipment is reserved by the Engineer when, in the Engineer's opinion, the equipment does not correspond to that specified.

1.17 MATERIAL SUBSTITUTIONS

- A. Material substitutions shall be allowed only where "or equal" is stated.
- B. Material substitution submittals shall, include complete description of the proposed substitute, the name of the material or equipment for which it is to be substituted, drawings, cuts, performance, test data and evidence that the proposed manufacturer or his established representative maintains a qualified service organization including spare parts and is available for competent service on short notice.
- C. Each bidder by submitting his bid represents that the proposal of such article, device, product, material, fixture, form or type of construction by name, make, catalog number of manufacturer which varies with the equipment specified shall be incorporated into the project without claims against the Owner for additional cost. The bidder shall be responsible for all additional costs incurred by others due to substitutions.
- D. The Architect/Engineer shall have the final approval of all submitted substitutions.

1.18 SUBMITTALS

- A. Approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- B. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed and approved the submittals.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and shall clearly identify equipment being submitted.

- D. Submittals shall be marked to show specification reference including the section and paragraph numbers.
- E. Submit each section separately and include the following:
 - 1. Information which confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. Submittals on all pumps shall be complete with performance curves marked with the design points.
 - 3. Submittals on electrical equipment shall be complete with all power and control wiring diagrams.
 - 4. Vibration isolators shall include operating weight and load distribution at each mounting point.
- F. The Contractor agrees that failure of manufacturer's submittal to conform to the above will result in a manufacturer's disqualification on this project.
- G. Submit samples as directed of items called for in the specifications; samples of the materials which the manufacturer will actually ship shall be submitted for approval after award of contract and properly labeled on this project.

1.19 PRODUCT HANDLING

- A. Following is in addition to Protection of Work and Property, General Requirements:
 - 1. Responsibility for care and protection of fire suppression work rests with the Contractor until it has been tested and accepted.
 - 2. After delivery, before, during and after installation, protect equipment and materials against theft, injury and damage from all causes.
 - 3. Protective covers, skids, plugs, caps and coating shall be provided to protect equipment materials from damage during construction.
 - 4. All equipment and material shall be stored under cover and off the ground.
 - 5. For outdoor storage, protective covers of sheet plastic shall be provided. Covers shall be of gauge required for the area involved and shall be reinforced to withstand wind, rain, sleet and snow. Equipment and material shall be set on skids or platforms of sufficient height to avoid deterioration from spattering and ground water.
 - 6. Plug open ends of pipes when work is stopped to prevent debris from entering the pipes.
 - 7. Coat polished or plated metal parts with Vaseline immediately after installation.
- B. The Contractor shall receive, properly house, handle, hoist, and deliver to proper location, equipment and other materials required for the contract.
- C. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect/Engineer and at no additional cost to the Owner.

1.20 COORDINATION DRAWINGS

- A. Detailed layout shop drawings on all systems as required in Division 23 must be coordinated with the field erection drawings of the HVAC, Plumbing, Fire Suppression and Electrical Contractors.
- B. The Sheet Metal Contractor shall prepare his work on reproducibles and submit 3/8" scale sepias of the sheet metal duct field erection shop drawings for the coordination procedures, and each Contractor will supply the necessary qualified personnel for these procedures which will be conducted by the General Contractor. This HVAC, Plumbing, Fire Suppression work to the sepias where conflicts are noted and achieve solutions to any conflicts that may exist.
- C. The General Contractor will be required to signify his acceptance of the results of the coordination procedures by signing and dating the master coordination mylar.
- D. Each Contractor will be required to correct his field erection drawing(s) used as a basis for the coordination procedures to complement the results of the procedures prior to submitting same for approval. No field erection shop drawings will be accepted for approval without having been coordinated.
- E. As part of the coordination procedures, applicable "Approval" or "Approved as Noted" copies of other trades' shop drawings will be transmitted to the Contractor. It will be each Contractor's responsibility to check these shop drawings to ascertain what effect, if any, these shop drawings have on that portion of the work under his direct responsibility. Each contractor will advise the General Contractor within forty-eight (48) hours of receipt of the shop drawings, in writing, indicating receipt of same and whether or not they have any effect on the work of his contract.

1.21 ELECTRICAL

A. Power Wiring

- 1. For the purpose of this specification, power wiring shall be defined as follows:
 - a. All wiring from the power source panelboards (or switchboard) to the disconnect switch to the equipment, and final connection to the equipment.
 - b. All wiring to control panels as indicated in the Electrical and Fire Suppression Contract Documents. (All control panels not indicated on the Electrical Contract Documents as receiving power shall do so by jumpers from other control panels, this wiring shall be considered control wiring as defined below).
- 2. All power wiring from the power source to the above noted switches and wiring from these switches to the equipment, including final connection to same, shall be provided under Division 26, Electrical.

B. Control Wiring

- 1. All other wiring required, whether line voltage or low voltage, internal or external to provide for the operation of the equipment shall be considered as control wiring.
- 2. All control wiring throughout the building, including wiring installed at piping or as specified shall be provided under Division 21.

- C. The Contractor shall furnish all motors, mounts, motor starters and remote mounted push-button controls for all electrically operated equipment furnished as part of the contract. The Contractor shall furnish all safety disconnects where described hereinafter. The Contractor shall furnish all speed control switches for all multi-speed motors. All motors shall have copper windings. (Aluminum windings will not be acceptable).
- D. This Contractor is completely responsible for the coordination with all other trades as to the correct voltage for all equipment requiring power. Equipment and or changes required to meet the project voltages will be the responsibility of this contractor.
- E. All push-button switches and starters shall be mounted under Division 26, Electrical.
- F. The Contractor shall provide all controls and control devices, all mounting for controls and all other electrical devices as specified and necessary for the complete installation and satisfactory operation of all electrically operated controls furnished under this Division.
- G. All locally mounted starters shall be furnished under Division 21, except as noted below. Where indicated hereinafter, starters shall be furnished as an integral part of equipment. Starters furnished in motor control centers shall be provided in Division 26, Electrical (refer to Electrical Drawings). Control of starters in motor control centers feeding fire suppression equipment shall be provided under Division 21.
- H. Starting equipment of each motor shall be of the proper voltage and HP rated for the motor it is to serve. All starters shall be of the enclosed type; NEMA Type 1, for general-purpose enclosures; NEMA Type 4 for watertight enclosures, and NEMA Type 12 for the dust-tight enclosures. Location of motor shall determine type of enclosure to be used.
- I. Manual motor starters for single-phase motors shall be one or two poles as required, consisting of a snap switch combined with a thermal overload device. It shall be impossible for the switch to be held in a closed position under a sustained motor overload. For resetting the overload mechanism, the switch lever shall be of a design where it has to be moved to the "off" position. Starter shall be enclosed in type of enclosure for area in which it is to be used.
- J. Magnetic starters for 3-phase motors shall be furnished with 110 volt holding coils, 120 volt fused transformers, normally open and normally closed auxiliary contact and overload relay heater elements in all three phases. Provide hand/off/auto selector switch along with running status lights and external reset button.
- K. Locate starters and associated starter controls in accessible locations wherever possible. Location of starters for roof mounted equipment above ceilings shall be located at accessible locations above ceiling. Locations shall be coordinated with furniture and equipment layouts for the optimum accessible location for installation and maintenance means.
- L. The Contractor shall be completely responsible for the coordination of control system with control interlocks between various items of fire suppression.

1.22 SCAFFOLDING

- A. The Contractor shall furnish and install scaffolding, ladders and runways required in connection with his work.

1.23 TEMPORARY OPENINGS

- A. Temporary openings not indicated, which may be required for purpose of bringing equipment into building, shall be as approved. General Contractor will perform work of providing and maintaining openings, and of restoring structure; but Contractor for whom temporary openings are provided shall bear costs thereof, and for restoring structure. Ample notice shall be given of size and location of such openings by Contractor requiring same.
- B. Holes provided in General Construction work to permit installation of lines for temporary fire suppression services will, after removal of such lines, be patched as specified under Division 01.

1.24 TEMPORARY SERVICE

- A. Temporary services are specified under Division 01, "General Requirements".

1.25 EXCAVATION

- A. All excavation is unclassified. The Contractor shall inspect the site and make allowance in his bid for soil to be excavated since no compensation will be given where rock is encountered.
- B. The Contractor, unless otherwise noted on the drawings, shall do all excavations for trenches, foundations, and pits of whatever kind necessary for the installation of this work. Bottom of trenches shall have the proper uniform grade wherever possible, or unless otherwise directed.
- C. Trenches are to be excavated to the widths, lines and grades indicated on the drawings and/or specified in the appropriate sections of these specifications. Trenches for piping are to be excavated to a minimum width of one (1) foot plus the outside diameter of the pipe. The trench shall be excavated in a manner such that the pipe will be located in the center of the trench with the trench bottom having the proper uniform grade in the direction of flow. Trenches shall be deep enough to provide a minimum of four (4) feet fill over the piping except as may be otherwise indicated on the drawings.
- D. In each excavation, trenches shall be carried to six inches below invert of pipe. Pipe shall be surrounded in all directions by a six-inch layer of selected crushed stone or gravel. If rock is encountered, carry trench to a point six inches below pipe invert. No pipe shall be bedded directly upon rock but shall be cushioned by a six-inch layer of selected crushed stone or gravel.
- E. The Contractor shall do any shoring, bracing, etc., necessary to maintain the banks of his excavation, shall make good and damage done to property of adjoining premises or work of other contractors due to his failure to properly shore his excavation. The Contractor shall do all pumping required to keep his excavations free of water including rental of pumps, temporary power and labor.
- F. All excavations shall be left open until work has been inspected and approved by the Architect. Sufficient time shall be allowed after notice is given that work is ready for inspection for making all examinations and tests. Under no circumstances shall excavated material be left even temporarily, where it will interfere with the building or other Contractor's operations.

- G. Excavations which pass under or within eighteen (18) inches of columns or wall foundations shall be backfilled up to the level of columns or wall foundations with concrete mixed in proportions to one part cement, three parts sand and five parts coarse aggregate. Excavations shall not undermine foundations at a slope of 1:1 or greater.
- H. All earth backfilling shall be made in layers not to exceed eight (8) inches and each layer shall be thoroughly tamped into place before the next layer is placed. Backfilling shall be clean earth, free of stone, pieces of concrete, rubbish and other foreign materials. Material frozen in lumps or material softer than the adjoining soil shall not be used in backfilling. The Contractor shall distribute on the premises as directed, all earth remaining after the backfilling.
- I. Any necessary blasting shall be performed by experienced and competent personnel in the most careful manner. All local ordinances and laws relating to blasting and storing of explosives must be strictly observed. No explosives shall be stored in the project properly. All contractors shall be notified prior to any blasting.
- J. Explosives used shall be subject to approval of the Architect. The blasting shall be properly covered with blasting mats.
- K. Any rock encountered within five (5) feet of pipes of building walls shall be removed without blasting. Any blasting required shall be performed at such times as to meet reasonable request of the Architect.
- L. The Contractor will do all patching of bituminous surfaces, concrete walks, driveways, streets, etc., necessary to complete his work. All patching shall match the existing surfaces. Painting shall be done by personnel skilled in their trades.
- M. Provide adequate temporary crossovers for pedestrian and vehicular traffic including guard rails, lamps, flags, as directed; remove same when necessity for such protection ceases.

1.26 CUTTING AND PATCHING

- A. The Contractor shall provide all floor and wall cuts as required for piping penetrations of existing construction.
- B. No cutting of bearing walls, beams, etc., shall be done without the approval of the Architect. All patching and finishing, etc., shall match the surroundings. All cutting and patching shall be done by workmen skilled in the trades and in the employ of the General Contractor for the project. All cutting shall be done with saw type edges to give a neat and workmanlike appearance. All pipe holes shall be core drilled unless specified otherwise.
- C. Should it be necessary to do any cutting and patching due to the failure of this Contractor to give proper information to the General Contractor, it shall be done at the expense of the Fire Suppression Contractor.

1.27 PAINTING AND FINISHING

- A. Except as specified herein, the finished painting of Fire Suppression Work within the building and on the roof shall be as specified under Division 09.

- B. All equipment shall have a factory-applied prime and finish coat of paint. Galvanized surfaces shall be considered as finished surfaces for equipment rooms and items concealed from view. Plastic products shall be acceptable without a finish coat of paint. All items of equipment marred or rusted, even though factory finished, shall be repainted; steel angles and steel supports for ductwork, piping or miscellaneous equipment shall have a prime coat of paint before installation.
- C. Paint all exposed piping, ductwork, equipment, and trim that does not have a factory applied finish. Refer to Division 09 "Painting" for paint materials, surface preparation and application of paint. Paint shall be semi-gloss, acrylic-enamel paint. Coat components with two (2) coats of finish paint over two (2) coats of rust inhibitive metal primer or approved equivalent based on component type.

1.28 CONCRETE WORK

- A. Concrete work shall be in accordance with Division 03.

1.29 SUSPENSION SUPPORT FOR PIPES, AND EQUIPMENT

- A. All pipes and equipment that are suspended shall be connected directly to the building steel. Where hangers are required between building steel points, supplementary steel members shall be added by the Contractor as required to adequately support the load.
- B. Pipes and ducts shall not be supported from other pipes or equipment.
- C. Hangers from joists shall be attached at the panel points. Pipes with weights of 50 pound per foot (total for single or multiple runs) routed parallel with bar joists shall be supported from a minimum of 3 joists at each hanger point (channel members between joists).

1.30 ACCESS PANELS – BUILDING

- A. Valves and equipment located concealed in walls or above ceilings, and are otherwise inaccessible shall be furnished with an access panel for each location. A hinged inconspicuous type access panel complete with frame, of such size and so located as to provide proper access for service and maintenance.
- B. The minimum size of each access panel shall be 18" x 18" unless physical restraints require a smaller door.
- C. Where such equipment is located above removable concealed spline push up type acoustical tile or metal pan ceilings, it shall be considered as accessible if the acoustical material is arranged for access to the space above the ceilings.
- D. Access panels shall be Milcor "DW", or equal, for drywall locations and Milcor "K", or equal, elsewhere.
- E. Panels and frames shall be prime painted.

- F. Panels shall be furnished under this Division and installed under another Division of this Specification.
- G. Panel material shall be steel except that construction shall be all aluminum in bathroom applications.
- H. When access panels or doors are installed in fire rated construction, they shall be fire rated to match the construction.

1.31 FIRESTOP PENETRATION PROTECTION SEALING SYSTEM

- A. Where pipes pass through fire partitions, firewalls, floors or ceilings, install a firestop that provides an effective barrier against the spread of fire, smoke, gases and water. Fire-stop material shall be packed tight, and completely fill clearances between pipe, sleeves and structure. All crack voids or holes (up to 4" diameter) shall be sealed using 3M brand Fire Barrier Caulk CP25 or putty 303 or an approved equal. Larger diameter or square holes, 3M system 7902, 7904, 7902R or 7904R or approved equal shall be in accordance with manufacturer's instructions.
- B. Fire-stopping material shall maintain its integrity while preventing the passage of flame, smoke, gases or water. Fire-stopping material shall be a one-part, intumescent elastomer noncombustible, noncorrosive and compatible with synthetic cable jackets as defined by ASTM E814 (UL 1479); and in addition for insulation materials, melting points shall be a minimum of 1700 degrees F for one-hour protection and 1850 degrees F for 2-hour protection.

1.32 RECORD DRAWINGS

- A. The Contractor shall furnish record as-built drawings to the Architect at completion and acceptance of the job. Transparencies of the original drawings with corrections shall be submitted as specified in the General Requirements.
- B. Record all changes from installation originally indicated. Record final location of underground lines by depth from finished grade and by offset distances in feet and tenths to surface improvement such as buildings, curb, or edges of walks. Where work appears on two or more drawings, Contractor shall mark changes on all drawings. Contractor shall mark changes on all drawings. At completion, furnish the above required transparencies to the A/E for approval and record. Drawings shall be certified to be record of work installed and signed by the Contractor. Work shall not be accepted until such drawings have been delivered to the A/E.

1.33 GUARANTEE

- A. In addition to the requirements stated in the specifications, the Contractor must guarantee all equipment, materials, and appurtenances installed by him to be free from all defects for a period of one year from date of final acceptance.
- B. Upon written notice from the A/E, the Contractor shall promptly correct all defects without additional cost to the Owner. This Contractor shall adjust each part of the entire installation for proper working order. Reports are to be submitted to the A/E and adjustments repeated until the

entire system is satisfactory. This Contractor must make good, at his own expense, any defects in materials or workmanship that may appear.

1.34 CLEAN UP

- A. The Contractor shall be held responsible for the general clean up of all areas affected by the work in the Contract. All rubbish and accumulative material shall be removed from the premises and the premises left "broom clean" upon completion.
- B. All stickers, rust, stains, labels and temporary covers shall be removed before final acceptance.
- C. Foreign matter shall be blown, vacuumed or flushed out of piping, pumps, motors, devices, switches, panels and equipment.
- D. Identification plates on equipment shall be free of excess paint and shall be polished.

1.35 OPERATION AND MAINTENANCE MANUALS

- A. Submit to the Engineer for approval three manuals covering details of operation maintenance for all apparatus requiring service. The Contractor shall arrange formal instruction sessions by competent representatives of the manufacturer for the Owner's operating personnel to cover the following:
 - 1. Service telephone number, fax number, websites, email addresses, business and service addresses and mobile telephone numbers of the installing contractor, and manufacturer and supplier and parts counters of pumps, condensate return units, and other components comprising the systems.
 - 2. Manufacturer's operating and maintenance manuals, including detailed parts lists with numbers, power and wiring diagrams for each piece of equipment and accessory requiring services or maintenance, the guarantee period and the name, address and phone number of the nearest sales and service organization for each item. Both on print and CD's (min 3 copies) form (PDF/MS Word).
 - 3. Cross out options that are not used on equipment sheets highlight options selected.
 - 4. Step-by-step procedure for starting, stopping, setpoint adjustment, monitoring and alarm enunciation for each system.
 - 5. Copies of inspection certificates provided by the City, County, State and insurance companies.
 - 6. Routine maintenance procedures for all fire suppression equipment.
- B. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of the manuals.

1.36 INSTRUCTION TO OPERATIONAL PERSONNEL

- A. Furnish the services of competent instructors to give full instruction to the designated Facilities personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system on the Contract Documents. Instructors

shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

- B. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. Provide 8 man-hours each of instruction for chemical treatment pumps, equipment, and other routine operational commands/functions required by the Owner's personnel.
- C. Instruction shall cover routine maintenance, wiring and power wiring diagrams and component analysis, preventative maintenance and scheduling, starting and stopping, alarm resets, trend-logging, setpoint adjustment, emergency and normal shutdown/startup, pressure control system, alarm date stamping and all else required by the Owner for complete usage/maintenance/adjustment of equipment in their intended systems.
- D. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of instructions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Materials and equipment shall be in accordance with the specifications as outlined in each specification section describing fire protection components, valves, piping, etc.
- B. All components shall be according to ASTM, ANSI, CISPI, NFPA and Code standards.
- C. Electrical equipment shall bear the underwriter label.

3.2 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3 PROJECT MANAGEMENT AND COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specification to ensure efficient and orderly installation of each part of the work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule
 2. Preparation of the Schedule of Values
 3. Installation and removal of temporary facilities and controls
 4. Delivery and processing of submittals
 5. Progress meetings
 6. Pre-installation conferences
 7. Project closeout activities
 8. Startup and adjustment of systems
 9. Project closeout activities
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into the work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

3.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequenced.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Number of Copies: Submit three opaque copies of each submittal. Architect, through Construction Manager, will return one copy.
 - a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect and Construction Manager will retain two copies; remainder will be returned. Markup and retain one returned copy as a Project Record Drawing.
 3. Refer to individual Sections for Coordination Drawing requirements for work in those Sections.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

3.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project Superintendent, provide other administrative and supervisory personnel as required for proper performance of the work.

3.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project Site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Procedures for processing field decisions and Change Orders
 - e. Procedures for requests for interpretations (RFIs)
 - f. Procedures for testing and inspecting
 - g. Procedures for processing Applications for Payment
 - h. Submittal procedures
 - i. Preparation of Record Documents
 - j. Use of the premises and existing building
 - k. Work restrictions
 - l. Owner's occupancy requirements
 - m. Responsibility for temporary facilities and controls
 - n. Construction waste management and recycling
 - o. Parking availability
 - p. Office, work, and storage areas
 - q. Equipment deliveries and priorities
 - r. First aid
 - s. Security
 - t. Progress cleaning
 - u. Working hours
 3. Minutes: Record and distribute meeting minutes.

- C. Pre-installation Conferences: Conduct a pre-installation conference at Project Site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents
 - b. Deliveries
 - c. Review of mockups
 - d. Possible conflicts
 - e. Time schedules
 - f. Manufacturer's written recommendations
 - g. Acceptability of substrates
 - h. Temporary facilities and controls
 - i. Coordination with other work
 - j. Protection of construction and personnel
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.

- b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements
 - 2) Status of submittals
 - 3) Off-site fabrication
 - 4) Site utilization
 - 5) Hazards and risks
 - 6) Progress cleaning
 - 7) Status of correction of deficient items
 - 8) Requests for interpretations (RFIs)
 - 9) Status of proposal requests
 - 10) Pending changes
 - 11) Status of Change Orders
 - 12) Pending claims and disputes
 - 13) Documentation of information for payment requests
- 3. Minutes: Record the meeting minutes.
- 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- E. Equipment locations: All fire suppression equipment shall be located to provide for manufacturer's recommended clearances, clearance for routine maintenance, clearance per code requirements and locations/clearances required for removal/replacement in the future.
 - 1. Manufacturer's recommended clearances shall include space for proper airflow and non-short circuiting airflow pathway, clearance for pumps (18" minimum around pumps), clearances for tube pulls (heat exchangers, chillers, coil pulls, etc); locate piping to be clear of these locations.
 - 2. Provide minimum 36" clearance around boilers, chillers, heat exchangers and other pressure vessels; note this is a minimum requirement, provide excess wherever possible. Provide minimum 42" clearance from power panels per the latest edition NEC having jurisdiction; include requirements for piping at such locations.
 - 3. Locate equipment in mechanical rooms to allow for future removal and replacement. Include heights to overhead piping where applicable. Wherever possible, clearances shall include removal/replacement as a whole entity without knock-down.
 - 4. Access platforms with metal grating shall be provided for equipment located outdoors such for power and control panels for equipment located on dunnage. This access system shall provide for maintenance and requirements per codes having jurisdiction. Platforms shall include stairs and handrails per OSHA regulations.
 - 5. Locate roof mounted equipment minimum 10' away from edges of roof. Where equipment is located closer, provide handrail system at roof edge as required per codes having jurisdiction. Maintain clearances from handrail system to power panels.

END OF SECTION 21 05 00

SECTION 21 05 29 – HANGERS & SUPPORTS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section includes hangers, supports, anchors, sleeves, seals, flashing and sealing for mechanical system piping and equipment.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include:
 - 1. Division 05 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
 - 2. Division 21 Sections on fire-suppression piping for fire-suppression pipe hangers.
 - 3. Division 21 Section "Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 REFERENCES

- A. ASTM A 36/A 36M-00a: Specification for Carbon Structural Steel
- B. ASTM A 780-00: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- C. ASTM C 533-95: Specification for Calcium Silicate Block and Pipe Thermal Insulation
- D. ASTM C 552-00 (Revised 2001): Specification for Cellular Glass Thermal Insulation
- E. ASTM C 1107-99: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- F. ASME B31.9-96: Building Services Piping
- G. 2001 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; Section IX, "Welding and Brazing Qualifications"
- H. AWS D1.1-00: Structural Welding Code – Steel
- I. MSS SP-58-93: Pipe Hangers and Supports – Materials, Design and Manufacture
- J. MSS SP-69-96: Pipe Hangers and Supports – Selection and Application
- K. MSS SP-89-98: Pipe Hangers and Supports – Fabrication and Installation Practices

- L. MSS SP-90-00: (Reaffirmed 1991): Guidelines on Terminology for Pipe Hangers and Supports
- M. MFMA-3-99: Metal Framing Standards Publication
- N. MFMA-102-99: Guidelines for the Use of Metal Framing
- O. SSPC-PA 1-2000: Paint Application Specification No. 1: Shop, Field and Maintenance Painting
- P. IAPMO PS 42-96: Pipe Alignment and Secondary Support Systems

1.4 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.5 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design seismic restraint hangers and supports for piping and equipment.

1.6 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing

engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pipe Hangers:
 - a. B-Line Systems, Inc.
 - b. Carpenter & Patterson, Inc.
 - c. Grinnell Corp.
 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. Unistrut Corp.
 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. Pipe Shields, Inc.
 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 - 2. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 - 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

2.4 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, and continuous threaded.

2.5 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustable, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit hanger rods. Inserts not allowed on piping 2 inches and larger.

2.6 FLASHING

- A. Metal Flashing: 26 gauge galvanized steel.

- B. Lead Flashing: 5 lb./sq. ft. sheet lead for waterproofing; one lb./sq. ft. sheet lead for soundproofing.
- C. Flexible Flashing: Thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

2.7 SLEEVES

- A. Sleeves for Pipes: Schedule 10, black steel.
- B. Sleeves for Ductwork: 18 gauge, black steel.
- C. Fire Stopping Insulation: Glass fiber type, non-combustible.
- D. Caulk: Acrylic sealant.

2.8 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Provide copper plated hangers and supports for copper piping.

2.9 SEALS

- A. Mechanical Type; interlocking synthetic rubber links; pressure plates and compression bolts. Include sleeve from same manufacturer.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. See Drawings for special areas (exposed truss and perforated metal ceiling).
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
1. Field assemblies and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricates from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

L. Supports shall secure pipes in place, shall prevent pipe vibration, maintain required grading by proper adjustment, provide for expansion and contraction and shall make a neat appearance. Supports shall be of strength and rigidity to suit loading, service and installed in a manner in which will not stress unduly the building construction. Hangers shall not be permitted from roof and floor slabs. Fasten hangers and supports to building framing wherever practicable. Where required, add supplementary steel members to support piping. Hangers shall be capable of vertical adjustment after piping is erected. Hanger rods shall not pierce ducts.

1. Support horizontal piping of steel as per following schedule:

Pipe Size (Inches)	Rod Diameter (Inches)	Max. Spacing (Feet)
Up to 1-1/2	3/8	6
2 and 3	1/2	10
4 and 5	5/8	12
6	3/4	12
8, 10 and 12	7/8	14

For horizontal piping larger than 12 inches, support piping from building steel at point indicated on drawings.

2. Support horizontal copper tubing as per following schedule:

Pipe Size (Inches)	Maximum Spacing (Feet)
Up to 1-1/2	6
2 to 3	10
3-1/2 and larger	12

Rod diameter shall be the same as specified for steel pipe. Support plastic piping in accordance with manufacturer's published recommendations.

3. Vertical Piping Supports

- a. Cast Iron and Steel: Support at each floor with a maximum spacing of 20 feet and not exceeding eight feet from ends of risers, unless otherwise required by expansion conditions.

- b. Copper Tubing: Support at each floor and between floors by stays or bracing to prevent rattling and vibration, unless otherwise required by expansion conditions.
- c. Plastic and Glass: Support in accordance with published manufacturer's recommendations.
- d. Support vertical lines which rise from lowest story with base fitting set on concrete or brick pier, or by hangers located on horizontal connections to riser.
- e. Bolt pipe riser clamps securely to pipe; rest clamp and extension on building structure. In special cases where directed, weld clamp to pipe and to building steel. Where required, provide supplementary steel members for clamp rest.

3.3 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping penetrate weather or waterproofed walls, floors, and roofs.
- B. For pipes through outside walls, turn flanges back into wall and caulk metal counter flash and seal.

3.4 SLEEVES

- A. Provide sleeves at all pipe penetrations of floor and walls.
- B. Extend sleeves through floors one inch above finished floor level. Grout sleeves in place. Staff joint with fire stop insulation and caulk seal airtight.
- C. Caulk all floor penetrations watertight between the floor and sleeve with fireproof caulk, airtight.
- D. Install chrome plated steel escutcheons at finished surface.
- E. Use mechanical seals at exterior wall pipe penetrations below grade.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.6 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.8 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Ceiling Plates: Where hanging rods or piping leave unsightly holes in ceilings in finished areas, provide plastic ceiling plates, Grinnell Figure 127 or cast iron ceiling plates with setscrew, Grinnell Figure 395.

END OF SECTION 21 05 29

SECTION 21 05 53 – IDENTIFICATION FOR FIRE SUPPRESSION PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Access panel and door markers.
 - 3. Pipe markers.
 - 4. Valve tags.
 - 5. Valve schedules.
 - 6. Warning tags.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 REFERENCES

- A. ASTM C 1036-91 (Reapproved 1997): Specification for flat glass.
- B. ASTM D 709-92 (Reapproved 1997): Specification for laminated thermo-setting materials.
- C. ASME A13.1-96: Scheme for the identification of piping systems.

1.4 SUBMITTALS

- A. Submit product data.
- B. Submit list of wording, symbols, letter size and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function and valve manufacturer's name and model number. (also include maintenance manuals)
- D. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: comply with ASME A13.1, "Scheme for the Identification of Piping Systems", for letter size, length of color field, colors and viewing angles of identification devices for piping.

1.6 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Color: Unless specified otherwise, conform the ANSI/ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Plastic Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number and serial number.
 - b. Capacity, operating and power characteristics and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions and speed.
 3. Size: 2-1/2 by 4 inches for control devices, dampers and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment. Markers for chemical fume or bio-hazard service shall be labeled accordingly.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe markers, General: Preprinted, color-coded, with lettering indicating service and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch-thick brass.
 2. Valve-Tag Fasteners: Brass S-hook.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 21 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of fire suppression equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Pumps and similar motor-driven units.
 2. Heat exchanger, coils, and similar equipment.
- B. Install equipment markers with permanent adhesive on or near each major item of fire suppression equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fire department hose valves and hose stations.
 - c. Meters, gages, thermometers, and similar units.
 - d. Pumps and similar motor-driven units.
 - e. Tanks and pressure vessels.
 - f. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation: Pre-tensioned pipe markers. Use size to ensure a tight fit.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets;

convenience and lawn-watering hose connections; and terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:
 - a. Fire Protection: 1-1/2 inches round.
2. Valve-Tag Color:
 - a. Fire Protection: Natural
3. Letter Color:
 - a. Fire Protection: Black.

3.5 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on and attach warning tags to equipment and other items where required.

3.7 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 21 05 53

SECTION 21 11 00 - FIRE SUPPRESSION SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Articles of Agreement and Standard General Condition, and other Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Pipe, fittings, valves, and connections for fire protection systems.
- B. Furnish pipe sleeves for placement.

1.3 RELATED WORK

- A. Division 21 – Fire Suppression Scope of Work
- B. Division 21 – Common Work Results for Fire Suppression
- C. Division 21 – Hangers, Supports and Anchors for Fire Suppression
- D. Division 21 – Manual Dry-Pipe Sprinkler Standpipe Systems

1.4 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- G. ANSI/ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
- H. ANSI/ASME B16.25 - Buttwelding Ends.
- I. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

- J. ANSI/ASME Section 9 - Welded and Seamless Wrought Steel Pipe.
- K. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- L. ANSI/ASTM A47 - Malleable Iron Castings.
- M. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- N. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- O. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- P. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- Q. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- R. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- S. NFPA 13 - Installation of Sprinkler Systems.
- T. NFPA 14 – Installation of Standpipe System
- U. 2020 Fire code of NYS with 2018 International Fire Code with amendments.
- V. 2020 Plumbing code of NYS with 2018 International Plumbing Code with amendments.
- W. 2020 Building code of NYS with 2018 International Building Code with amendments.
- X. Local borough, city, town, municipality, etc.
- Y. Local state UCC Codes

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 13 for sprinkler systems.
- B. Conform to NFPA 14 – Installation of Standpipe System (Manual Dry-pipe)
- C. Welding Materials and Procedures: Conform to ASME Code.
- D. Employ certified welders in accordance with ANSI/ASME Section 9. AWS D10.9.
- E. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- F. Materials shall be FM approved and shall bear the FM label or markings.

1.6 SUBMITTALS

- A. Submit product data under provisions of Division 01 and 21 – Common Work Results for Fire Suppression.
- B. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals.
- C. Indicate valve data and ratings.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures. Maintain in place until installation.

PART 2 - PRODUCTS

2.1 PIPE

- A. Black Steel Pipe: ASTM A53 ERW, Grade B, Schedule 40; Class 150, Malleable iron threaded fittings and threaded joints for sizes 2" and smaller. Wrought-steel butt welding fittings and outlets, and welded joints or Victaulic grooved couplings for sizes 2 ½" and larger. All fittings shall have a UL Listed pressure rating of no less than 300 psi.
- B. Wall thicknesses less than schedule 40 will not be permitted.
- C. Cut grooved or threaded thin wall pipe will not be permitted.
- D. Plain end pipe, fittings with locking lugs or shear bolts will not be permitted.
- E. All pipe and fittings shall be rated at 300 psi minimum.
- F. Tees shall be made with fittings or Weld-o-let/Thread-o-lets. Bolt-on or saddle type tees not permitted.

2.2 JOINT MATERIALS

- A. Threaded Joint Compound.
- B. Rigid couplings to have angle bolt pad design. If tongue and recessed type rigid couplings are used they require a torque wrench for installation. Install all couplings in strict accordance with manufacturers' latest installation instructions. Couplings shall be manufactured by Victaulic Company of America or as approved. UL used and FM approved specifically for fire service.

2.3 UNIONS, FLANGES, AND COUPLINGS

- A. Unions: 150 psi class malleable iron for threaded ferrous piping as allowed per NFPA 13 for piping under 6" where pressures do not exceed 300 psi. Where pressure approaches 300 psi, extra-heavy fittings must be used.
- B. Flanges: 250 psi class forged steel slip-on flanges for ferrous piping.
- C. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; "C" shaped composition sealing gasket, steel bolts, nuts, and washers.
- D. Flanged fittings shall be extra-heavy class and be compatible with all flanged valves.

2.4 ACCEPTABLE MANUFACTURERS – GATE VALVES

- A. Nibco
- B. Mueller
- C. Kennedy

2.5 GATE VALVES

- A. Bronze, rising stem, inside screw, renewable composition disc.
- B. Iron body, bronze trim, rising stem, OS&Y, solid wedge.

2.6 ACCEPTABLE MANUFACTURERS – GLOBE OR ANGLE VALVES

- A. Nibco
- B. Mueller
- C. Kennedy

2.7 GLOBE OR ANGLE VALVES

- A. Bronze, rising stem, inside screw, renewable composition disc.
- B. Iron body, bronze trim, rising stem, OS&Y, renewable composition disc.

2.8 ACCEPTABLE MANUFACTURERS – CHECK VALVES

- A. Nibco

- B. Mueller
- C. Kennedy

2.9 CHECK VALVES

- A. Check valves shall be approved type, iron body, bronze mounted for 175 pounds pressure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends to full inside diameter.
- B. Remove burrs and bevel plain end ferrous pipe.
- C. Remove scale and foreign material, inside and outside, before assembly.

3.2 INSTALLATION – PIPE

- A. Coat threaded ends with pipe lubricant compound.
- B. Install piping in accordance with NFPA 13 for sprinkler systems.
- C. Do not penetrate building structural members unless indicated.
- D. Install 3/4 inch valved hose connections at ends of branch lines, and at cross mains and system low points for complete system drainage.
- E. Provide a 1-inch diameter Inspector's Test Connection at the end of the most distant sprinkler line for each sprinkler system on each floor and install a 1-inch globe valve 7'-0" above the floor. The outlet shall be fitted with a 1-inch, 45 degree elbow, and half-inch smooth bore brass outlet. If the discharge point is not visible at the test valve location, a sight glass will be required. Pipe the discharge through a clean flow tube and to the storm drainage systems.

3.3 INSTALLATION – VALVES

- A. Install valves with stems upright or horizontal, not inverted.
- B. Provide gate valves for shut-off or isolation service.
- C. Provide drain valves at main shut-off valves, low points of piping and apparatus.

3.4 PAINTING OF PIPE, FITTINGS AND VALVES

- A. All sprinkler pipe, fittings and valves shall be painted red including both concealed and visible components.
- B. The piping systems shall be thoroughly cleaned of all dirt, debris, cutting oil, etc. before beginning of painting.
- C. The paints shall be enamel for use on metal, low luster. One coat is sufficient.

END OF SECTION 21 11 00

SECTION 22 00 00 - PLUMBING SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, and other Division 01 Specification Sections, apply to this Section.

1.2 REQUIREMENTS

- A. The conditions as defined in Division 22 – Common Work Results for Plumbing, shall apply to all Division 22 specifications.
- B. This contractor shall carefully read the above mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read, or attend to any paragraph or items contained herein.

1.3 INTENT

- A. It is the intent of this specification and accompanying drawings to provide Plumbing systems, as specified herein and as shown on the contract drawings. The drawings show the general arrangement and extent of the work to be done. Exact location and arrangement of all components shall be determined as the work progresses. Plans are subject to such modification as may be necessary at the time of installation in order to meet construction conditions. Any adjustments shall be made by the Contractor, without extra charge.
- B. The project is to be completed during normal working hours.

1.4 WORK INCLUDED

- A. These specifications and accompanying drawings are intended to cover the furnishing by this Contractor of all labor, material and equipment of every kind necessary for the complete installation of the various systems and such other material and equipment as hereinafter specified and shall not be limited to the following:
 - 1. Provide domestic hot water and cold water piping.
 - 2. Provide domestic water recirculation pumps.
 - 3. Provide domestic water heaters.
 - 4. Provide pipe and pipe fittings for the various systems.
 - 5. Provide valves and cocks for the various systems.
 - 6. Provide sanitary sewer and vent piping.
 - 7. Provide storm water piping.
 - 8. Provide natural gas piping.

9. Provide fuel oil piping.
 10. Provide painting of piping systems
 11. Provide pipe insulation of plumbing systems.
 12. Provide water meters.
 13. Provide backflow preventer for domestic service.
 14. Provide fire and domestic water service.
 15. Provide O.S. & Y valve.
 16. Provide reduced pressure zone backflow prevention devices.
 17. Provide double check backflow prevention devices.
 18. Provide gas, water heater, valves, supply valves, supply piping, and return piping.
 19. Provide plumbing fixtures. Provide drainage specialties: roof drains, floor drains, cleanouts, etc.
 20. Provide complete natural gas piping system from the gas meter/regulator set to all fixtures and equipment within the building requiring gas.
 21. Provide electric heat trace for exposed piping.
 22. Provide drains for HVAC equipment.
 23. Provide excavation and backfill for below grade work.
 24. Provide expansion joints, loops, anchors and guides.
 25. Provide vibration bases, steel supports and hangers for all equipment and piping.
 26. Provide disinfection and flushing of all water piping.
 27. Provide testing, adjusting and placing in service all systems and equipment installed
- B. The above list is presented for general guidance only and does not necessarily cover the entire requirement of the project as shown on the drawings and/or specified hereafter.
- C. The following items of work related to Plumbing will be performed by others as follows:
1. The General Contractor shall install all roof drains furnished by the Plumbing Contractor and indicated on the Plumbing and Architectural Drawings.
 2. The General Contractor shall provide all foundations and pads for equipment, paint all piping in finished areas, provide all base flashing on roof, and build in all sleeves, unless otherwise noted.
 3. The General Contractor shall install all access panels furnished by the Plumbing Contractor.
 4. The Plumbing Contractor shall provide valved make up water outlets and gas outlets for heating and air conditioning equipment for final connection to equipment by the HVAC Contractor.
 5. The Plumbing Contractor shall provide floor drains for HVAC equipment. Drainage piping from equipment to drains shall be by the HVAC Contractor.
 6. The Electrical Contractor shall do all power wiring for equipment.
 7. The gas utility company will provide gas from street main to building, including the installation of the meter and pressure regulator.

1.5 ADDITIONAL MATERIALS AND INSTALLATION INCLUDED

- A. This contractor shall, as part of his base bid, provide the following materials and installations for the complete systems installation.
1. The contractor shall provide one double offset for each 80'-0" of run for each piped service in the building. One offset shall consist of four (4) elbow fittings, 12' of additional pipe, and three (3) hangers of the same joining method and materials as the piping system the offset is to be installed in.
 2. The contractor shall provide one offset for each 80'-0" of run for each piped service in the building. One offset shall consist of two (2) elbow fittings, 6' of additional pipe, and one (1) hanger of the same joining method and materials as the piping system the offset is to be installed in.
 3. The contractor shall provide five (5) additional 3/4" ball valves for installation at locations to be determined during the construction.
 4. The contractor shall provide five (5) additional 1-1/2" ball valves for installation at locations to be determined during the construction.
 5. The contractor shall provide two (2) additional 3/4" check valves for installation at locations to be determined during the construction.
 6. The contractor shall provide two (2) additional 1-1/2" check valves for installation at locations to be determined during the construction.
 7. The contractor shall provide five (5) additional 3/4" unions for installation at locations to be determined during the construction.
 8. The contractor shall provide five (5) additional 1-1/2" unions for installation at locations to be determined during the construction.
 9. The contractor shall provide five (5) additional 3/4" dielectric unions for installation at locations to be determined during the construction.
 10. The contractor shall provide five (5) additional 1-1/2" dielectric unions for installation at locations to be determined during the construction.
 11. The contractor shall provide two (2) additional 1/2" balancing valve assemblies (consisting of a balancing valve, a check valve and a ball valve) for installation at locations to be determined during the construction.
 12. The contractor shall provide two (2) additional Type (A) Floor Drains for installation at locations to be determined during the construction.
 13. The contractor shall provide one (2) additional Type (B) Floor Drains for installation at locations to be determined during the construction.

14. The contractor shall provide one (2) additional Type (A) Floor Sinks for installation at locations to be determined during the construction.
15. The contractor shall provide five (5) additional Floor Cleanouts for installation at locations to be determined during the construction.
16. The contractor shall provide two (2) additional Lavatory Supply Trap and Tailpiece Insulation kits for installation at locations to be determined during the construction.
17. Provide expansion loops with anchors in domestic hot water and hot water return piping per the requirements of ASPE and ASHRAE.

- B. The contractor shall provide a cost break-down for each of the items listed in paragraph A, above. The cost shall be broken down to indicate material, accessories and labor required for the installation of the items listed above. Upon projected completion of work, contractor shall submit a credit to the owner for additional material and installation which is unused.

1.6 WORK AS A SUBCONTRACTOR

- A. When the Plumbing work is subcontracted, the exact scope of work may be limited or added to at the discretion of the General Contractor. A subcontractor shall, therefore, verify the extent of his work with the General Contractor.

1.7 RELATED WORK SPECIFIED ELSEWHERE

The following related work items are included in separate divisions and Sections as follows:

- A. General Requirements, Division 01.
- B. Site Work – Division 02.
- C. Concrete – Division 03.
- D. Roof Flashing – Division 07.
- E. Painting – Division 09.
- F. Common Work Results for Plumbing – Division 22.
- G. Common Work Results for Fire Suppression – Division 21.
- H. Electrical – Division 26.

1.8 REFERENCES

- A. 2020 Plumbing code of NYS with 2018 International Plumbing Code with amendments

- B. 2020 Building code of NYS with 2018 International Building Code with amendments
- C. 2020 Fire code of NYS with 2018 International Fire Code with amendments
- D. National Fire Codes (NFPA) – latest edition
- E. All State and Local Rules and Regulations
- F. ASPE Guidelines
- G. CISPI Guidelines

PART 2 - PRODUCTS

- A. As specified in the following related sections.

PART 3 - EXECUTION

- A. All Plumbing systems shall be complete and fully operational.

END OF SECTION 22 00 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the general requirements that apply to the Plumbing and Plumbing Controls.
- B. The following work is specified under other Divisions, unless otherwise noted or specified hereinafter:
 - 1. Painting except as herein specified, Division 09.
 - 2. Electrical Power, Division 26.
 - 3. Installation of starters, contractors, thermal overload switches and remote push buttons, Division 26.

1.3 INTENT

- A. Requirements specified herein shall govern applicable portions of Plumbing whether so stated therein or not.
- B. It is the intent of this specification and accompanying drawings to describe and indicate the general manufacture, erection and installation of the equipment and connection to same specified herein and shown on the drawings. It is not intended that the specifications and drawings describe and indicate each piece of equipment required for installation, for where items are intended or required for satisfactory installation and are considered to be the accepted practice of the trade, they shall be considered to be both specified and indicated. Drawings are diagrammatic in nature; for piping systems; water piping is tapped off the bottom of the pipe and steam and steam condensate piping is tapped off the top of the pipe; provide all tees, elbows and swing joints as required for hookup to coils or branch piping as required for this work whether they are indicated on the drawings or not.
- C. It shall be understood that the Contractor as hereinafter mentioned shall be the Plumbing Contractor unless specifically noted otherwise.
- D. The Contractor shall furnish all plant, labor and material necessary for the complete and satisfactory installation of all Plumbing work for this contract.

- E. The Contractor shall assume the entire responsibility for the materials, workmanship and satisfactory operation of the various mechanical systems, and other work as specified herein and/or as shown on the drawings.
- F. The Contractor shall schedule and coordinate all work in close cooperation with all trades working on this project.
- G. All drawings and portions of the drawings, all floor plans, risers, details, schematics and specifications indicated shall apply and are part of the plumbing contract.
- H. Any discrepancy or conflict noted between or within the above referenced documents shall be brought to the attention of the Architect/Engineer, in writing, a minimum of three (3) days prior to submittal of bids. The Architect/Engineer shall resolve issues prior to bid submittal.
- I. This Contractor shall carefully read the above mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read, or attend to, any paragraph or items contained therein. Failure to bring any conflicts or discrepancies to the attention of the Architect/Engineer, in writing, prior to bid submittal shall not constitute grounds for extras and/or change orders. Costs resultant from this failure shall be borne by this Contractor.

1.4 DEFINITIONS

- A. Following definition of terms and expressions used in this section are in addition to listing given in Supplementary Conditions:
 - 1. "Provide" shall mean "furnish and install" unless otherwise indicated.
 - 2. "Herein" shall mean the contents of a particular section where this term appears.
 - 3. "Indicated" shall mean "Indicated on contract drawings".
 - 4. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 5. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 - 6. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 - 7. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 - 8. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 - 9. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic
 - b. CPVC: Chlorinated polyvinyl chloride plastic
 - c. NP: Nylon plastic
 - d. PE: Polyethylene plastic
 - e. PVC: Polyvinyl chloride plastic

10. The following are industry abbreviations for rubber materials:
 - a. CR: Chlorosulfonated polyethylene synthetic rubber
 - b. EPDM: Ethylene propylene diene terpolymer rubber
11. For additional abbreviations see the Abbreviations and Symbols Drawings.

1.5 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall be responsible for establishing grades and elevations, and checking of all interferences, and shall verify all dimensions and locations in the field.
- B. Contract drawings for mechanical work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, ducts, piping and approximate sizes and locations of equipment outlets. Mechanical trades shall follow these drawings in layout of their work, consult general construction, structural and electrical drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed.
- C. The Contractor shall verify with the A/E before bidding any item of piping or piping arrangement which may be incomplete, incorrect or indefinite. After contract is let, the A/E's decision shall be final.
- D. All trades shall cooperate and confer with each other as to locations of their materials and equipment before erecting work, so as to avoid interference as much as possible, and in such a manner that will in no way retard progress of construction. In instances where interferences develop, the contractor shall relocate the work as required by the A/E regardless of which work was installed first.
- E. Where job conditions require reasonable changes to indicate locations and arrangement, make such changes without extra cost to Owner. This is not to be construed to permit redesigning of the various systems.
- F. Additional and supplementary drawings may, from time to time, be furnished, and the same, when made, are to constitute a part of the original contract. These drawings will be made to clarify the contract drawings and will not depart materially therefrom.
- G. The A/E specifically reserves the right, up to the time of roughing-in, to exactly define the position of the equipment to be installed and connected to and arrangement of these connections.
- H. Special attention is called to the contract drawings and specifications involving general construction, electrical work and details thereon. Bidders are notified to carefully scrutinize these documents for the details affecting the performance of the mechanical trades.
 1. Install all supply piping with adequate stops on each supply to all fixtures and or equipment to be connected to distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures and or equipment. Install stops in locations where they can be easily reached for operation.

- I. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture or equipment. Valves are specified in Divisions 22 and 23.

1.6 WORK INCLUDED

- A. These specifications, and accompanying drawings are intended to cover the furnishing by this Contractor of all labor, material and all equipment of every kind necessary for the complete installation of the various systems, and such other materials and equipment as hereinafter specified, and shall include, but not be limited to the following:
1. Water service from point 5'-0" outside of building to meter in Water Service Room as indicated.
 2. Reduced pressure zone backflow prevention devices for the incoming domestic water service.
 3. Double Check backflow prevention device for the incoming fire service.
 4. Cold water system from water service from Water Service Room to all fixtures and equipment requiring cold water. Cold water piping to domestic water heaters.
 5. Cold water supply to fill heating and cooling systems complete with a Reduced Pressure Zone backflow preventer and terminating with gate valve or ball valve.
 6. Domestic hot water system includes gas water heaters, valves, supply valves, supply piping, and return piping to fixtures and equipment requiring hot water as indicated.
 7. Water supply specialties including water meter, shock absorbing devices, backflow preventers, hot water recirculating pump, wall hydrants, thermometers, etc.
 8. Sanitary drainage and vent system, and stormwater system within the building.
 9. Sanitary sewerage system from building to points indicated.
 10. Stormwater drainage system from building to points indicated.
 11. Drainage specialties, including roof drains, floor drains, cleanouts, etc.
 12. Domestic hot water recirculating system within the building as indicated.
 13. Complete natural gas piping system from the gas meter/regulator set to all fixtures and equipment within the building requiring gas. Terminate at heating equipment or water heating equipment with gas cock.
 14. Fuel oil pump set and all fuel oil piping.
 15. Electric heat trace for exposed piping.
 16. Provide drains for HVAC equipment.
 17. All excavation and backfilling required for the above work.
 18. All pipe and fittings for the various systems.
 19. All necessary valves, gas cocks and shutoffs.
 20. All expansion joints, loops, anchors and guides.
 21. All vibration bases, steel supports and hangers for all equipment and piping.
 22. Insulation for piping and equipment as herein specified.
 23. All plumbing fixtures as hereinafter specified, including handicapped fixtures compliance with the handicapped code.
 24. All painting of pipe and equipment in the mechanical rooms and other unoccupied areas, and all painting of piping in no ceiling areas.
 25. Flush all water pipe and disinfect as specified.
 26. Setting of all sleeves and inserts in place.
 27. Testing, adjusting and placing in service all systems and equipment installed.

28. Install all supply piping with adequate stops on each supply to all fixtures and or equipment to be connected to distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures and or equipment. Install stops in locations where they can be easily reached for operation.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture or equipment. Valves are specified in Divisions 22 and 23.
 29. All plumbing fixtures, drains, floor drains, equipment, piping, fittings, valves, etc. shall be commercial grade for business.
- B. The above is presented for general guidance only and does not necessarily cover the entire requirement of the project as shown on the drawings and/or as specified hereinafter.

1.7 SCHEDULE OF WORK

- A. The Contractor shall schedule all of his work to conform to the Job Progress Schedule as submitted by the General Contractor or Construction Manager, and approved by the A/E.

1.8 PREMIUM TIME WORK

- A. The following work shall be performed at night or weekends other than holiday weekends, as directed and coordinated with the Owner:
1. Tie connections to all existing systems.
 2. All work in the existing building finished space.

1.9 RELATED WORK SPECIFIED ELSEWHERE

- A. The following related work items are included in separate Divisions as follow:
1. General Requirements – Division 01
 2. Site Work – Division 02
 3. Concrete – Division 03
 4. Roof Flashing – Division 07
 5. Painting – Division 09
 6. HVAC – Division 23
 7. Fire Protection – Division 21
 8. Electrical – Division 26
- B. The following items of work related to plumbing will be performed by others as follows:
1. All utilities for the building, including sanitary, storm, and domestic water services to points indicated will be by Site Contractor.
 2. The General Contractor shall provide all foundations and pads for equipment, paint all piping in finished areas, provide all base flashing on roof, build in all sleeves, unless otherwise noted.

3. The Electrical Contractor shall do all power wiring for plumbing equipment unless otherwise noted.
4. The General Contractor shall install all access panels furnished by the Plumbing Contractor.
5. The General Contractor shall install all roof drains provided by the plumbing contractor and indicated on the Plumbing Drawings.
6. The HVAC Contractor shall provide make-up water connections to heating and air conditioning equipment from valved outlets left by the Plumbing Contractor.
7. The HVAC Contractor shall provide drainage piping from his equipment to drains provided by the Plumbing Contractor.
8. The HVAC Contractor shall provide condensate drainage piping from all air conditioning equipment to points of connection provided by the Plumbing Contractor.
9. The Electrical Contractor shall furnish and install the emergency generator.
10. The gas utility company will provide gas from the street main to the building including the installation of the meter and pressure regulator.

1.10 WORK AS A SUBCONTRACTOR

- A. When the plumbing work is subcontracted, the exact scope of work may be limited or added to at the discretion of the General Contractor. A subcontractor shall, therefore, verify the extent of his work with the General Contractor.

1.11 INTERFERENCE WITH THE OWNER'S NORMAL OPERATION

- A. All work shall be performed in such a manner as not to interfere with the normal work operations in adjacent spaces or buildings.
- B. In no way shall the Contractor:
 1. Block or restrict the means of egress for adjacent spaces.
 2. Decrease the fire rating of walls, partitions, ceilings, doors or combination thereof of adjacent spaces or of means of egress.
 3. Interrupt safety systems or in any way adversely affect the safety of people or materials in adjacent spaces.
- C. The Contractor shall provide acoustical isolation of the work area via temporary doors, partitions, etc., adequate to allow normal work functions.
- D. The Contractor shall provide exhaust fans, dust proof temporary partitions and any containment measure required to prevent dirt, dust, or fumes from reaching adjacent work spaces.
- E. All personal traffic and material delivery shall be routed so as to absolutely minimize travel through adjacent work area.
- F. For healthcare applications follow guidelines to limit infectious construction debris and duct in accordance with the job specific IERA Construction Containment Plan.

1.12 VISIT TO SITE

- A. The Contractor shall visit the site and thoroughly acquaint himself with all existing conditions relative to type and source of service available. He shall verify location and extent of these services and consider routing, interferences and excavation required by the contract and any and all other difficulties that may be encountered.
- B. Submission of a proposal shall be construed as evidence that such an examination has been made.
- C. Failure to visit the site shall not constitute sufficient reason to warrant claims for extra monies for difficulties not apparent in the contract documents.

1.13 MANNING THE PROJECT

- A. The Contractor shall, upon initiation of construction, keep a suitable force of men on the site at all times in order to lace all sleeves, inserts, outlet boxes, fixtures and provide all other openings as are required for the satisfactory installation of equipment.

1.14 FEES AND PERMITS

- A. The Contractor shall secure all permits and pay all fees, required by local and state governing bodies, necessary to complete his phase of the construction. Failure to investigate all applicable payments before the bid submission shall not constitute grounds for additional monies from the Owner. The Owner shall be furnished with all certificates of approval.
- B. The Contractor shall provide insurance and bonding as required by the Building Owner or as stated in the General Conditions.

1.15 CODES AND STANDARDS

- A. The design, construction and installation of all materials and equipment shall be in compliance with the latest edition of all national, state and local codes or standards.
- B. The codes and standards referred to are minimum standards. Where the requirements of these specifications and the accompanying drawings exceed those of the codes and standards, the drawings and specifications shall be followed.

1.16 BASIS OF DESIGN

- A. The layout is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements and service connections required for these particular items have been considered in making the layout. The contractor may use the equipment of any manufacturer whose name is approved for substitution on that item of equipment after he had ascertained that all provisions of MATERIAL SUBSTITUTIONS will be complied with and that all required service connections will be made at no additional cost to the Owner.

- B. Except where dimensions are shown, the drawings are diagrammatic and shall not be scaled. Exact location of fixtures, apparatus, duct work and piping shall be determined by dimensions on the site. Contractor shall refer to architectural plans and details for exact dimensions.
- C. The drawings indicate the locations of apparatus, fixtures, and piping shall be followed as closely as possible. If before the installation it is found necessary to change the location to accommodate conditions at the building, such changes shall be made at no additional cost to the Owner, and as approved by the Architect/Engineer.
- D. Equipment requiring operation, service or maintenance during the life of the system shall be made easily accessible.
- E. Piping shall not be run within 48" of switchboards, panelboards or motor control centers.
- F. No piping shall be run in the dedicated equipment space as defined in the N.E.C. (NFPA 70). The dedicated equipment space is the space equal to the width and depth of the equipment and extending from the floor to a height of 6ft. Refer to the National Electrical Code section 110.26 (E) for further information. No piping, ducts, sprinklers, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone. It is this contractor's responsibility to coordinate with the electrical contractor for all phases of this project.
- G. Use of open-flame devices in work shall be accompanied by fire extinguishing apparatus within 25 feet of work location. Provide Fire Watch review of the work during each shift.

1.17 QUALITY OF MATERIALS

- A. Where a specific model and manufacturer of equipment is specified, the Contractor shall provide what is specified without substitution. Where specified as "or approved equal", the Contractor may substitute equipment except that the burden is upon the Bidder to prove such equality. If the Bidder elects to prove such equality, he must request the Architect's approval in writing to substitute such item for the specified item, stating the cost difference involved with supporting data, and samples, if required, to permit a fair evaluation of the proposed substitute with respect to quality, serviceability, warranty and cost.
- B. Where a specific model of equipment is specified along with an approval equal manufacturer, no substitution will be allowed. The Contractor shall submit one of the manufacturers listed.
- C. Final approval of competitive equipment is reserved by the Engineer when, in the Engineer's opinion, the equipment does not correspond to that specified.

1.18 MATERIAL SUBSTITUTIONS

- A. Material substitutions shall be allowed only where "or equal" is stated.
- B. Material substitution submittals shall, include complete description of the proposed substitute, the name of the material or equipment for which it is to be substituted, drawings, cuts, performance, test data and evidence that the proposed manufacturer or his established

representative maintains a qualified service organization including spare parts and is available for competent service on short notice.

- C. Each bidder by submitting his bid represents that the proposal of such article, device, product, material, fixture, form or type of construction by name, make, catalog number of manufacturer which varies with the equipment specified shall be incorporated into the project without claims against the Owner for additional cost. The bidder shall be responsible for all additional costs incurred by others due to the substitutions.
- D. The Architect/Engineer shall have the final approval of all submitted substitutions.

1.19 SUBMITTALS

- A. Approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- B. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed and approved the submittals.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and shall clearly identify equipment being submitted.
- D. Submittals shall be marked to show specification reference including the section and paragraph numbers.
- E. Submit each section separately and include the following:
 - 1. Information which confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. Submittals on all pumps shall be complete with performance curves marked with the design points.
 - 3. Submittals on electrical equipment shall be complete with all power and control wiring diagrams.
 - 4. Vibration isolators shall include operating weight and load distribution at each mounting point.
- F. The Contractor agrees that failure of manufacturer's submittal to conform to the above will result in a manufacturer's disqualification on this project.
- G. Submit samples as directed of items called for in the specifications; samples of the materials which the manufacturer will actually ship shall be submitted for approval after award of contract and properly labeled on this project.

1.20 PRODUCT HANDLING

- A. Following is in addition to Protection of Work and Property, General Requirements:
1. Responsibility for care and protection of mechanical work rests with the Contractor until it has been tested and accepted.
 2. After delivery, before, during and after installation, protect equipment and materials against theft, injury and damage from all causes.
 3. Protective covers, skids, plugs, caps and coating shall be provided to protect equipment materials from damage during construction.
 4. All equipment and material shall be stored under cover and off the ground.
 5. For outdoor storage, protective covers of sheet plastic shall be provided. Covers shall be of gauge required for the area involved and shall be reinforced to withstand wind, rain, sleet and snow. Equipment and material shall be set on skids or platforms of sufficient height to avoid deterioration from spattering and ground water.
 6. Plug open ends of pipes when work is stopped to prevent debris from entering the pipes.
 7. Protect plumbing fixtures and other equipment with enamel or glazed surface, from damage by covering and/or coating, as recommended in Bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures," issued by Plumbing Fixture Manufacturers' Association.
 8. Coat polished or plated metal parts with Vaseline immediately after installation.
- B. The Contractor shall receive, properly house, handle, hoist, and deliver to proper location, equipment and other materials required for the contract.
- C. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect/Engineer and at no additional cost to the Owner.

1.21 COORDINATION DRAWINGS

- A. Detailed layout shop drawings on all systems as required in Division 01 – Project Coordination, Division 21, 22, 23, 1n3 26, must be coordinated with field erection drawings for Architectural, HVAC, Plumbing, Fire Protection, and Electrical Systems by the respective contractors.
- B. Prepare coordination drawings for all areas by building, floor area and/or phase, of the project. Close attention should be implemented where limited space availability necessitates maximum utilization of space for efficient installation of different components.
- C. Mechanical, Electrical and Plumbing Prime Contractors are responsible to prepare coordination drawings to a Scale of $\frac{1}{4}" = 1'-0"$ or larger; detailing major elements, components, and systems of mechanical and electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including but not limited to the following:
1. Proposed locations of ductwork, piping, conduit, equipment, and materials.
 2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 4. Equipment connection and support details.
 5. Exterior wall and foundation penetrations.

6. Fire rated wall, floor, ceiling, and roof penetrations.
 7. Sizes and location of required concrete pads and bases.
 8. Valve stem movement.
 9. Sleeves.
- D. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Clearly define relationships between sleeves, piping, ductwork, conduit, ceiling grid, lighting, fire sprinkler, HVAC equipment and other mechanical, plumbing, and electrical equipment with other components of the building such as beams, columns, ceilings, and walls.
- E. Prepare reflected ceiling plans to coordinate and integrate installations of air outlets and inlets, light fixtures, communication systems components, sprinkler, and other ceiling mounted items.
- F. Resolve conflicts between trades prepare composite coordination drawings and obtain signatures from all affected Prime Contractors on original composite drawings. Submit coordination drawings to the Architect/Engineer and Construction Manager for approval.
- G. Mechanical, Electrical and Plumbing Prime Contractors are to first submit their respective shop drawings for approval, to the Architect/Engineer, in order to make any necessary changes prior to going through the coordination process.
- H. Coordination drawings to be signed off by affected Contractors within 45 days of Notice to Proceed. A Coordination drawing timeline schedule shall be developed and tracked.
- I. The coordination drawings shall be coordinated with the construction and phasing schedule.
- J. The routing process will begin with the HVAC Contractor who shall take the lead in the coordination of their work with all affected trades.
- K. The HVAC Contractor shall prepare CAD drawings to be used as the basis for coordination drawings in all areas or as determined by the Construction Manager (Scale: 1/4" = 1'-0" or larger). These drawings shall be completed in digital format. All architectural features shall be accounted for in preparation of this drawing; i.e., permanent, casework, interior columns, partitions, finish ceiling and height, lighting and roof elevations, etc. The HVAC Contractor will provide CAD files and drawings showing all of the approved ductwork. HVAC Contractor is to locate all piping with orange lines. Forward drawings to the Plumbing Contractor.
- L. The Plumbing Contractor is to locate the plumbing lines with blue lines and sprinkler lines and head locations with red lines, and resolve all conflicts and determine locations and elevations, and forward drawing to the Electrical Contractor.
- M. The Electrical Contractor to indicate all lighting fixtures, panels with associated clearances, duct banks, bus duct, conduit racks and all individual conduits 1 1/2" and larger in with green lines, and resolve all conflicts and determine locations and elevations and forward to the General Construction Contractor.
- N. The General Construction Contractor will have the last coordination review. Provide overlaid coordination drawings for all General Construction work and resolve all conflicts. All architectural features shall be detailed clearly, i.e. permanent casework, interior columns,

partitions, finish ceiling and roof elevations, etc. Provide a ceiling layout detailed coordination drawing showing ceilings, lights, diffusers, etc.

- O. Contractors to provide underground coordination drawings for all underground utilities; show exact location of piping stub ups, floor drains, etc. as required.
- P. Prime Contractors shall be responsible for all costs associated with creating CAD files.
- Q. All coordination meetings will be held in the Construction Manager's field office or as required by the Architect/Engineer. As each coordination drawing is completed, Contractors are to meet with the Construction Manager to review and resolve all conflicts on the coordination drawings. Contractors are required to distribute shop drawings, cut sheets and submittals to other Prime Contractors where appropriate. Approved coordination drawings will also be available for reviewing at the Construction Managers field office.
- R. All Contractors shall provide a hard copy of the coordination drawings for review by the Architect/Engineer.
- S. Once complete and signed off, the HVAC, Plumbing and Electrical Contractors will submit dimensioned wall and slab penetration drawings and housekeeping pad drawings to the appropriate parties.
- T. If the coordination drawing process is not complete, Mechanical, Electrical and Plumbing Contractors will provide wall penetration drawings to the General Construction Contractor no later than five (5) days prior to wall erection.
- U. All Prime Contractors must install the work in accordance with the coordinated drawings at no additional cost to the Owner. No additional compensation will be made for extra ductwork offsets, piping and/or conduit or retrofit work due to improper component location, or lack of Contractor(s) coordination.
- V. All Prime Contractors shall take special care in verifying with the Electrical Contractor that the equipment matches the characteristics of the power being supplied. The Electrical Contractor is similarly bound.
- W. The Mechanical, Electrical and Plumbing Drawings are schematic in nature and are not intended to show every offset and detail. The Mechanical, Electrical and Plumbing Contractors will make adequate provisions in their bid to accommodate the actual conditions, provide all required ductwork, piping and conduit offsets per the coordination drawings, without additional cost to the Owner.
- X. The Mechanical, Electrical and Plumbing Contractors shall hang streamers from all above ceiling equipment that will require access. This is in addition to any specification requirements for tags, labels, etc. Shop drawings should also highlight these areas for Architect/Engineer's review. In addition, the Contractors shall notify the Construction Manager and Architect/Engineer of all areas where equipment maintenance access is difficult. Coordinate architecturally placed access doors with points of mechanical/electrical systems requiring that access.
- Y. Specific Requirements – Required Information to be provided on Coordination Drawings:

1. General Construction/Structural Work Information including but not limited to:
 - a. Openings and sleeve locations required in slabs, walls, beams, and other structural elements, including required openings not indicated on the Contract Documents.
 - b. Slab edge locations
 - c. Embed locations, as described above. Note embedded steel angles at edges of sump and sewage ejector pits, to accept basin covers.
 - d. Wall and chase spaces for housing HVAC, Plumbing, or Electrical items.
 - e. Access doors in coordination with the respective contractor systems.
 - f. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
2. HVAC Work Information including but not limited to:
 - a. Sizes and bottom elevations of rectangular ductwork, including angle bracing, flanges, and support systems.
 - b. Sizes and centerline elevations of round ductwork, piping and conduit runs
 - c. Acoustical lining in ductwork.
 - d. Identification of ductwork pressure class.
 - e. Dimensions of major components, such as dampers, valves, diffusers, registers, cleanouts, coils, VAV boxes, HVAC equipment, and electrical distribution equipment.
 - f. Fire-rated enclosures around ductwork.
 - g. Access panels required.
 - h. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
3. Plumbing and Fire Protection Information including, but not limited to:
 - a. Sizes and centerline elevations of piping runs.
 - b. Locations of plumbing valves, equipment, and fixtures.
 - c. Locations of standpipes, floor control assemblies, fire hose valves, mains, piping, branch lines, pipe drops, sprinkler heads, fire pumps/controllers, and jockey pumps.
 - d. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
4. Electrical Work Information including, but not limited to:
 - a. Runs of vertical and horizontal conduit, 1 1/4" diameter and larger
 - b. Light fixture locations
 - c. Exit light locations
 - d. Smoke detector and other fire alarm locations
 - e. Panelboards, switchboards, switchgear, transformers, busways, generators and motor control center, exit signs, and emergency battery pack locations.
 - f. Locations of pull boxes and junction boxes, dimensioned from column centerlines
 - g. Access panels required.
 - h. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.

5. Ceiling Systems and Plenum Space Information including, but not limited to:
- a. For HVAC, Plumbing, Fire Protection, Fire Alarm, Electrical, Controls and Telecommunications Work penetrating acoustical ceilings, show locations of each item (including sprinkler heads, diffusers, grilles, access doors, light fixtures, smoke detectors exit signs, speakers, and other visible ceiling mounted devices) relative to the acoustical ceiling grid.
 - b. Locate components within ceiling plenums to accommodate layout of light fixtures indicated on Drawings. Clearly indicate areas of conflict between light fixtures and other components on Coordination drawings.
 - c. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
- Z. The Sheet Metal Contractor shall prepare his work on reproducibles and submit 1/4" scale CAD drawings of the sheet metal duct field erection shop drawings for the coordination procedures, and each Contractor will supply the necessary qualified personnel for these procedures which will be conducted by the General Contractor. The HVAC, Plumbing and Fire Suppression work to the drawings where conflicts are noted and achieve solutions to any conflicts that may exist.
- AA. The General Contractor will be required to signify his acceptance of the results of the coordination procedures by signing and dating the master coordination print.
- BB. Each Contractor will be required to correct his field erection drawing(s) used as a basis for the coordination procedures to complement the results of the procedures prior to submitting same for approval. No field erection shop drawings will be accepted for approval without having been coordinated.
- CC. As part of the coordination procedures, applicable "Approval" or "Approved as Noted" copies of other trades' shop drawings will be transmitted to the Contractor. It will be each Contractor's responsibility to check these shop drawings to ascertain what effect, if any, these shop drawings have on that portion of the work under his direct responsibility. Each contractor will advise the General Contractor within forty-eight (48) hours of receipt of the shop drawings, in writing, indicating receipt of same and whether or not they have any effect on the work of his contract.

1.22 ELECTRICAL

A. Power Wiring

1. For the purpose of this specification, power wiring shall be defined as follows:
- a. All wiring from the power source panelboards (or switchboard) to the disconnect switch to the equipment, and final connection to the equipment.
 - b. All wiring to control panels as indicated in the Electrical and Plumbing Contract Documents. (All control panels not indicated on the Electrical Contract Documents as receiving power shall do so by jumpers from other control panels, this wiring shall be considered control wiring as defined below).

2. All power wiring from the power source to the above noted switches and wiring from these switches to the equipment, including final connection to same, shall be provided under Division 26, Electrical.
- B. Control Wiring
1. All other wiring required, whether line voltage or low voltage, internal or external to provide for the operation of the equipment shall be considered as control wiring.
 2. All control wiring throughout the building, including wiring installed at piping, or as specified shall be provided under this Division 22.
- C. The Contractor shall furnish all motors, mounts, motor starters and remote mounted push-button controls for all electrically operated equipment furnished as part of the contract. The Contractor shall furnish all safety disconnects where described hereinafter. The Contractor shall furnish all speed control switches for all multi-speed motors. All motors shall have copper windings. (Aluminum windings will not be acceptable).
- D. This Contractor is completely responsible for the coordination with all other trades as to the correct voltage for all equipment requiring power. Equipment and or changes required to meet the project voltages will be the responsibility of this contractor.
- E. All push-button switches and starters shall be mounted under Division 26, Electrical.
- F. The Contractor shall provide all controls and control devices, all mounting for controls and all other electrical devices as specified and necessary for the complete installation and satisfactory operation of all electrically operated controls furnished under this Division.
- G. All locally mounted starters shall be furnished under Division 22, except as noted below. Where indicated hereinafter, starters shall be furnished as an integral part of equipment. Starters furnished in motor control centers shall be provided in Division 26, Electrical (refer to Electrical Drawings). Control of starters in motor control centers feeding plumbing equipment shall be provided under Division 23.
- H. Starting equipment of each motor shall be of the proper voltage and HP rated for the motor it is to serve. All starters shall be of the enclosed type; NEMA Type 1, for general-purpose enclosures; NEMA Type 4 for watertight enclosures, and NEMA Type 12 for the dust-tight enclosures. Location of motor shall determine type of enclosure to be used.
- I. Manual motor starters for single-phase motors shall be one or two poles as required, consisting of a snap switch combined with a thermal overload device. It shall be impossible for the switch to be held in a closed position under a sustained motor overload. For resetting the overload mechanism, the switch lever shall be of a design where it has to be moved to the "off" position. Starter shall be enclosed in type of enclosure for area in which it is to be used.
- J. Magnetic starters for 3-phase motors shall be furnished with 110 volt holding coils, 120 volt fused transformers, normally open and normally closed auxiliary contact and overload relay heater elements in all three phases. Provide hand/off/auto selector switch along with running status lights and external reset button.
- K. Locate starters and associated starter controls in accessible locations wherever possible. Location of starters for roof mounted equipment above ceilings shall be located at accessible

locations above ceiling. Locations shall be coordinated with furniture and equipment layouts for the optimum accessible location for installation and maintenance means.

- L. The Contractor shall be completely responsible for the coordination control system with control interlocks between various items of plumbing equipment.

1.23 SCAFFOLDING

- A. The Contractor shall furnish and install scaffolding, ladders and runways required in connection with his work.

1.24 TEMPORARY OPENINGS

- A. Temporary openings not indicated, which may be required for purpose of bringing equipment into building, shall be as approved. General Contractor will perform work of providing and maintaining openings, and of restoring structure; but Contractor for whom temporary openings are provided shall bear costs thereof, and for restoring structure. Ample notice shall be given of size and location of such openings by Contractor requiring same.
- B. Holes provided in General Construction work to permit installation of lines for temporary services will, after removal of such lines, be patched as specified under Division 01.

1.25 TEMPORARY SERVICE

- A. Temporary services are specified under Division 01, "General Requirements".

1.26 EXCAVATION

- A. All excavation is unclassified. The Contractor shall inspect the site and make allowance in his bid for soil to be excavated since no compensation will be given where rock is encountered.
- B. The Contractor, unless otherwise noted on the drawings, shall do all excavations for trenches, foundations, and pits of whatever kind necessary for the installation of this work. Bottom of trenches shall have the proper uniform grade wherever possible, or unless otherwise directed.
- C. Trenches are to be excavated to the widths, lines and grades indicated on the drawings and/or specified in the appropriate sections of these specifications. Trenches for piping are to be excavated to a minimum width of one (1) foot plus the outside diameter of the pipe. The trench shall be excavated in a manner such that the pipe will be located in the center of the trench with the trench bottom having the proper uniform grade in the direction of flow. Trenches shall be deep enough to provide a minimum of four (4) feet fill over the piping except as may be otherwise indicated on the drawings.
- D. In each excavation, trenches shall be carried to six inches below invert of pipe. Pipe shall be surrounded in all directions by a six-inch layer of selected crushed stone or gravel. If rock is encountered, carry trench to a point six inches below pipe invert. No pipe shall be bedded directly upon rock but shall be cushioned by a six-inch layer of selected crushed stone or gravel.

- E. The Contractor shall do any shoring, bracing, etc., necessary to maintain the banks of his excavation, shall make good and damage done to property of adjoining premises or work of other contractors due to his failure to properly shore his excavation. The Contractor shall do all pumping required to keep his excavations free of water including rental of pumps, temporary power and labor.
- F. All excavations shall be left open until work has been tested and inspected and approved by the Construction Manager/General Contractor. Sufficient time shall be allowed after notice is given that work is ready for inspection for making all examinations and tests. Under no circumstances shall excavated material be left even temporarily, where it will interfere with the building or other Contractor's operations.
- G. Excavations which pass under or within eighteen (18) inches of columns or wall foundations shall be backfilled up to the level of columns or wall foundations with concrete mixed in proportions to one part cement, three parts sand and five parts coarse aggregate. Excavations shall not undermine foundations at a slope of 1:1 or greater.
- H. All earth backfilling shall be made in layers not to exceed eight (8) inches and each layer shall be thoroughly tamped into place before the next layer is placed. Backfilling shall be clean earth, free of stone, pieces of concrete, rubbish and other foreign materials. Material frozen in lumps or material softer than the adjoining soil shall not be used in backfilling. The Contractor shall distribute on the premises as directed, all earth remaining after the backfilling.
- I. Any necessary blasting shall be performed by experienced and competent personnel in the most careful manner. All local ordinances and laws relating to blasting and storing of explosives must be strictly observed. No explosives shall be stored in the project properly. All contractors shall be notified prior to any blasting.
- J. Explosives used shall be subject to approval of the Architect. The blasting shall be properly covered with blasting mats.
- K. Any rock encountered within five (5) feet of pipes of building walls shall be removed without blasting. Any blasting required shall be performed at such times as to meet reasonable request of the Architect.
- L. The Contractor will do all patching of bituminous surfaces, concrete walks, driveways, streets, etc., necessary to complete his work. All patching shall match the existing surfaces. Painting shall be done by personnel skilled in their trades.
- M. Provide adequate temporary crossovers for pedestrian and vehicular traffic including guard rails, lamps, and flags, as directed; remove same when necessity for such protection ceases.

1.27 CUTTING AND PATCHING

- A. The Contractor shall provide all floor and wall cuts as required for piping penetrations of existing construction.
- B. No cutting of bearing walls, beams, etc., shall be done without the approval of the Architect. All patching and finishing, etc., shall match the surroundings. All cutting and patching shall be done by workmen skilled in the trades and in the employ of the General Contractor for the

project. All cutting shall be done with saw type edges to give a neat and workmanlike appearance. All pipe holes shall be core drilled unless specified otherwise.

- C. Should it be necessary to do any cutting and patching due to the failure of this Contractor to give proper information to the General Contractor, it shall be done at the expense of the Plumbing Contractor.

1.28 PAINTING AND FINISHING

- A. Except as specified herein, the finished painting of Plumbing Work within the building and on the roof shall be as specified under Division 09.
- B. All mechanical equipment shall have a factory-applied prime and finish coat of paint. Galvanized surfaces shall be considered as finished surfaces for equipment rooms and items concealed from view. Plastic products shall be acceptable without a finish coat of paint. All items of equipment marred or rusted, even though factory finished, shall be repainted; steel angles and steel supports for ductwork, piping or miscellaneous equipment shall have a prime coat of paint before installation.
- C. Paint all exposed piping, equipment, and trim that does not have a factory applied finish. Refer to Division 09 "Painting" for paint materials, surface preparation and application of paint. Paint shall be semi-gloss, acrylic-enamel paint. Coat components with two (2) coats of finish paint over two (2) coats of rust inhibitive metal primer or approved equivalent based on component type.

1.29 CONCRETE WORK

- A. Concrete work shall be in accordance with Division 03.

1.30 SUSPENSION SUPPORT FOR EQUIPMENT

- A. All pipes and equipment that are suspended shall be connected directly to the building steel. Where hangers are required between building steel points, supplementary steel members shall be added by the Contractor as required to adequately support the load.
- B. Pipes and ducts shall not be supported from other pipes, ducts, or equipment.
- C. Hangers from joists shall be attached at the panel points. Pipes and ducts with weights of 50 pound per foot (total for single or multiple runs) routed parallel with bar joists shall be supported from a minimum of 3 joists at each hanger point (channel members between joists).

1.31 ACCESS PANELS – BUILDING

- A. Valves and equipment located concealed in walls or above ceilings, and are otherwise inaccessible shall be furnished with an access panel for each location. A hinged inconspicuous type access panel complete with frame, of such size and so located as to provide proper access for service and maintenance.

- B. The minimum size of each access panel shall be 18" x 18" unless physical restraints require a smaller door.
- C. Where such equipment is located above removable concealed spline push up type acoustical tile or metal pan ceilings, it shall be considered as accessible if the acoustical material is arranged for access to the space above the ceilings.
- D. Access panels shall be Milcor "DW", or equal, for drywall locations and Milcor "K", or equal, elsewhere.
- E. Panels and frames shall be prime painted.
- F. Panels shall be furnished under this Division and installed under another Division of this Specification.
- G. Panel material shall be steel except that construction shall be all aluminum in bathroom applications.
- H. When access panels or doors are installed in fire rated construction, they shall be fire rated to match the construction.

1.32 FIRESTOP PENETRATION PROTECTION SEALING SYSTEM

- A. Where pipes pass through fire partitions, firewalls, floors or ceilings, install a firestop that provides an effective barrier against the spread of fire, smoke, gases and water. Fire-stop material shall be packed tight, and completely fill clearances between pipe, sleeves and structure. All crack voids or holes (up to 4" diameter) shall be sealed using 3M brand Fire Barrier Caulk CP25 or putty 303 or an approved equal. Larger diameter or square holes, 3M system 7902, 7904, 7902R or 7904R or approved equal shall be in accordance with manufacturer's instructions.
- B. Fire-stopping material shall maintain its integrity while preventing the passage of flame, smoke, gases or water. Fire-stopping material shall be a one-part, intumescent elastomer noncombustible, noncorrosive and compatible with synthetic cable jackets as defined by ASTM E814 (UL 1479); and in addition for insulation materials, melting points shall be a minimum of 1700 degrees F for one-hour protection and 1850 degrees F for 2-hour protection.

1.33 RECORD DRAWINGS

- A. The Contractor shall furnish record as-built drawings to the Architect at completion and acceptance of the job. Transparencies of the original drawings with corrections shall be submitted as specified in the General Requirements.
- B. Record all changes from installation originally indicated. Record final location of underground lines by depth from finished grade and by offset distances in feet and tenths to surface improvement such as buildings, curb, or edges of walks. Where work appears on two or more drawings, Contractor shall mark changes on all drawings. Contractor shall mark changes on all drawings. At completion, furnish the above required transparencies to the A/E for approval and

record. Drawings shall be certified to be record of work installed and signed by the Contractor. Work shall not be accepted until such drawings have been delivered to the A/E.

1.34 GUARANTEE

- A. In addition to the requirements stated in the specifications, the Contractor must guarantee all equipment, materials, and appurtenances installed by him to be free from all defects for a period of one year from date of final acceptance.
- B. Upon written notice from the A/E, the Contractor shall promptly correct all defects without additional cost to the Owner. This Contractor shall adjust each part of the entire installation for proper working order. Reports are to be submitted to the A/E and adjustments repeated until the entire system is satisfactory. This Contractor must make good, at his own expense, any defects in materials or workmanship that may appear.

1.35 CLEAN UP

- A. The Contractor shall be held responsible for the general clean up of all areas affected by the work in the Contract. All rubbish and accumulative material shall be removed from the premises and the premises left "broom clean" upon completion.
- B. All stickers, rust, stains, labels and temporary covers shall be removed before final acceptance.
- C. Foreign matter shall be blown, vacuumed or flushed out of piping, pumps, fans, motors, devices, switches, panels, and equipment.
- D. Identification plates on equipment shall be free of excess paint and shall be polished.

1.36 OPERATION AND MAINTENANCE MANUALS

- A. Submit to the Engineer for approval three manuals covering details of operation maintenance for all apparatus requiring service. The Contractor shall arrange formal instruction sessions by competent representatives of the manufacturer for the Owner's operating personnel to cover the following:
 - 1. Service telephone number, fax number, websites, email addresses, business and service addresses and mobile telephone numbers of the installing contractor, and manufacturer and supplier and parts counters of pumps, water heaters, backflow preventers, and other components comprising the systems.
 - 2. Manufacturer's operating and maintenance manuals, including detailed parts lists with numbers, power and wiring diagrams for each piece of equipment and accessory requiring services or maintenance, the guarantee period and the name, address and phone number of the nearest sales and service organization for each item. Both on print and CD's (min 3 copies) form (PDF/MS Word).
 - 3. Cross out options that are not used on equipment sheets, highlight options selected.
 - 4. Step-by-step procedure for starting, stopping, setpoint adjustment, monitoring and alarm enunciation for each system.

5. Copies of inspection certificates provided by the City, County, State and insurance companies.
 6. Routine maintenance procedures for all plumbing equipment.
- B. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of the manuals.

1.37 INSTRUCTION TO OPERATIONAL PERSONNEL

- A. Furnish the services of competent instructors to give full instruction to the designated Facilities personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system on the Contract Documents. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
- B. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. Provide 8 man-hours each of instruction for, pumps, water heaters, compressors, air dryers, vacuum pumps, and other equipment required by the Owner's personnel.
- C. Instruction shall cover routine maintenance, wiring and power wiring diagrams and component analysis, preventative maintenance and scheduling, starting and stopping, alarm resets, trend-logging, setpoint adjustment, emergency and normal shutdown/startup, relative pressure control system for the morgue, alarm date stamping and all else required by the Owner for complete usage/maintenance/adjustment of equipment in their intended systems.
- D. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of instructions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Materials and equipment shall be in accordance with the specifications as outlined in each specification section describing plumbing components, fixture valves, piping, etc.
- B. All components shall be according to ASTM, ANSI, CISPI, NFPA and Code standards.
- C. Electrical equipment shall bear the underwriter label.

3.2 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3 PROJECT MANAGEMENT AND COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specification to ensure efficient and orderly installation of each part of the work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's Construction Schedule
 - 2. Preparation of the Schedule of Values
 - 3. Installation and removal of temporary facilities and controls
 - 4. Delivery and processing of submittals
 - 5. Progress meetings
 - 6. Pre-installation conferences
 - 7. Project closeout activities
 - 8. Startup and adjustment of systems

9. Project closeout activities

- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into the work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

3.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequenced.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Number of Copies: Submit three opaque copies of each submittal. Architect, through Construction Manager, will return one copy.
 - a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect and Construction Manager will retain two copies; remainder will be returned. Markup and retain one returned copy as a Project Record Drawing.
 3. Refer to individual Sections for Coordination Drawing requirements for work in those Sections.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

3.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project Superintendent, provide other administrative and supervisory personnel as required for proper performance of the work.

3.6 PROJECT MEETINGS

- A. General: Attend meetings and conferences at Project Site, unless otherwise indicated.
1. Agenda: Be prepared for the meeting agenda. Distribute the agenda to all invited attendees.
 2. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Attend a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Procedures for processing field decisions and Change Orders
 - e. Procedures for requests for interpretations (RFIs)
 - f. Procedures for testing and inspecting
 - g. Procedures for processing Applications for Payment
 - h. Submittal procedures
 - i. LEED requirements
 - j. Preparation of Record Documents
 - k. Use of the premises and existing building
 - l. Work restrictions
 - m. Owner's occupancy requirements
 - n. Responsibility for temporary facilities and controls
 - o. Construction waste management and recycling
 - p. Parking availability
 - q. Office, work, and storage areas
 - r. Equipment deliveries and priorities
 - s. First aid
 - t. Security
 - u. Progress cleaning
 - v. Working hours

3. Minutes: Record and distribute meeting minutes.
- C. Pre-installation Conferences: Attend a pre-installation conference at Project Site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents
 - b. Deliveries
 - c. Review of mockups
 - d. Possible conflicts
 - e. Time schedules
 - f. Manufacturer's written recommendations
 - g. Acceptability of substrates
 - h. Temporary facilities and controls
 - i. Coordination with other work
 - j. Protection of construction and personnel
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Attend progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- 1) Review schedule for next period.
- b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements
 - 2) Status of submittals
 - 3) Off-site fabrication
 - 4) Site utilization
 - 5) Hazards and risks
 - 6) Progress cleaning
 - 7) Status of correction of deficient items
 - 8) Requests for interpretations (RFIs)
 - 9) Status of proposal requests
 - 10) Pending changes
 - 11) Status of Change Orders
 - 12) Pending claims and disputes
 - 13) Documentation of information for payment requests
3. Minutes: Record the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- E. Equipment locations: All plumbing equipment shall be located to provide for manufacturer's recommended clearances, clearance for routine maintenance, clearance per code requirements and locations/clearances required for removal/replacement in the future.
 1. Manufacturer's recommended clearances shall include space for proper airflow and non-short circuiting airflow pathway (plumbing equipment, etc), clearance for pumps (18" minimum around pumps), 30" clearance or complete access door swings clearances for tube pulls (heat exchangers, coil pulls, etc); locate piping to be clear of these locations.
 2. Provide minimum 36" clearance around water heaters, heat exchangers and other pressure vessels; note this is a minimum requirement, provide excess wherever possible. Provide minimum 48" clearance from power panels per the latest edition NEC having jurisdiction; include requirements for piping and ductwork at such locations.
 3. Locate equipment in mechanical rooms to allow for future removal and replacement. Include heights to overhead piping where applicable. Wherever possible, clearances shall include removal/replacement as a whole entity without knock-down.
 4. Access platforms with metal grating shall be provided for equipment located outdoors such for power and control panels for equipment located on dunnage. This access system shall provide for maintenance and requirements per codes having jurisdiction. Platforms shall include stairs and handrails per OSHA regulations.
 5. Locate roof mounted equipment minimum 10' away from edges of roof. Where equipment is located closer, provide handrail system at roof edge as required per codes having jurisdiction. Maintain clearances from handrail system to power panels.
 6. Locate air intakes 25' away from exhaust outlets and plumbing vents for healthcare facilities.

7. Locate air intakes for kitchen air intakes min 10' away from exhaust outlets and plumbing vents from kitchen exhaust fans.

3.7 CONNECTION TO EXISTING UTILITIES

- A. If connecting to an existing piping system (water, gas, oil, sewer, steam, condensate, etc.). It shall be the responsibility of this contractor to verify the integrity of the piping system being connected. Coordinate all system shutdowns with the owner. All applicable testing and acceptance will apply.
- B. Existing Pipe Testing: The contractor shall remove a section of piping at the point of connection between new and existing. The contractor shall determine the integrity of the existing piping after analysis of the piping section for tube wall thickness, scaling and corrosion. The analysis shall determine the ability for tie-in, pressure testing ability and remaining useful life. The contractor shall guarantee the piping integrity at the point of tie-in and subsequent acceptance. For existing piping not currently being used; the contractor shall pressure test in order to determine integrity and subsequent acceptance. Report all results in writing to the Architect/Engineer.

END OF SECTION 22 05 00

SECTION 22 05 10 - PLUMBING DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other and Division 22 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of Division 22 systems.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
 - 1. Division 22 Sections for demolishing, cutting, patching, or relocating plumbing items.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.
 - 1. Coordinate with Owner's personnel, who will establish special procedures for removal and salvage.

1.5 SUBMITTALS

- A. Proposed Dust-Control and Noise-Control, Infectious Containment Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- D. Predemolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Comply with Division 1 Section "Photographic Documentation." Submit before Work begins.
- E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project site to comply with requirements herein. Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.

3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Requirements of system downtime and scheduling with site personnel.

1.7 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
 1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. Owner assumes no responsibility for condition of areas to be selectively demolished.
 1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
 1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.
 - a. Processed concrete finishes.
 - b. Stonework and stone masonry.
 - c. Ornamental metal.
 - d. Matched-veneer woodwork.
 - e. Preformed metal panels.
 - f. Roofing.
 - g. Firestopping.

- h. Window wall system.
- i. Stucco and ornamental plaster.
- j. Terrazzo.
- k. Finished wood flooring.
- l. Fluid-applied flooring
- m. Aggregate wall coating.
- n. Wall covering.
- o. Swimming pool finishes.
- p. HVAC enclosures, cabinets, or covers.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installations requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect/Engineer.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
 - 1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner, Building Manager, or Construction Manager will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- D. Utility Requirements: Refer to Division 21, 22, 23 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Division 1 Section "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.

5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 1 Section "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management."
 10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations begun.
 11. Provide demolition on an on-going basis, schedule permitting. Demolition of existing systems or portions thereof shall be performed without interruption of the operation of the central heating plant.
 12. Remove demolition debris on a continuous and daily basis as work proceeds. Do not leave debris in the room.
 13. Schedule and locate dumpster space as required by the project and coordinate location with Owner's personnel.

14. Remove from site boilers and other large pieces of equipment immediately upon movement. Coordinate schedule of removal trains and cranes with Owner's personnel so that removal minimizes impact on-site traffic movement.
 15. Maintain the operation of the central heating plant due to requirements of site steam while demolition is in progress. Where conditions cannot be met, coordinate and schedule with Owner's personnel and other requirements to minimize down-time.
- B. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without Architect's approval.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- F. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- G. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- H. Concrete Slabs-on-Grade: Saw cut perimeter of area to be demolished, then break up and remove.
- I. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

- J. Roofing: Remove no more existing roofing than can be covered in one day by new roofing. Refer to applicable Division 7 Section for new roofing requirements.
- K. Air-Conditioning Equipment: Remove equipment without releasing refrigerants or by properly reclaiming refrigerant before removal of equipment.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Division 1 Section "Construction Waste Management."
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 22 05 10

SECTION 22 05 16 – EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Flexible pipe connections.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets and swing joints.
- D. Pipe guides.
- E. Pipe anchors.

1.2 RELATED WORK

- A. Division 22 – Scope or Work
- B. Division 22 – Common Work Results for Plumbing
- C. Division 22 – Plumbing Piping
- D. Division 22 – Pipe Insulation Building Plumbing Systems

1.3 REFERENCES

- A. Conform to Standards of Expansion Joint Manufacturer's Association.

1.4 DESIGN CRITERIA

- A. Base expansion calculations on 40°F installation temperature to 210°F for hot water heating and 140°F for domestic hot water and glycol system, plus 30 percent safety factory.

1.5 SUBMITTALS

- A. Submit shop drawings under provisions of Division 01 and 22.
- B. Flexible pipe connector shop drawing data to include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

- C. Expansion joint shop drawings to include maximum allowable.

1.6 QUALITY ASSURANCE

- A. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for expansion fittings and loops by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of expansion fittings and loops that are similar to those indicated for this Project in material, design, and extent.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexonics
- B. Metraflex
- C. Keflex
- D. Grinnell

2.2 FLEXIBLE PIPE CONNECTIONS

- A. For steel piping construct with stainless steel inner hose and braided exterior sleeve.
- B. For copper piping construct with stainless steel inner hose and braided exterior sleeve.
- C. Use connectors suitable for minimum 125 psi WSP and 450°F and 200 psi WSG and 250°F.
- D. Construct spool pieces to extract size for insertion of flexible connection.

2.3 EXPANSION JOINTS

- A. Steel Piping 3 inch and Under: Stainless steel bellows type with anti-torque device, limit stops and internal guide, screwed ends except 3 inch which shall have flanged ends.
- B. Steel Piping over 3 inch: External ring controlled type with hydraulically formed 2-ply stainless steel bellows, flanged ends.

- C. Copper Piping: All bronze type with two-ply phosphor bronze bellows, anti-torque device limit stops, internal guides and solder joint end.
- D. Use joints suitable for minimum 125 psi WSP and 400°F, and 200 psi WOG and 250°F.

2.4 PIPE GUIDES

- A. Provide factory fabricated guides of heavy steel consisting of bolted two section outer cylinder and base with two section guiding spider bolted tight to pipe. Single guide and spiders to clear pipe and insulation and cylinder. Provide guides of length recommended by manufacturers to allow indicated travel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.
- B. Provide pipe guides at expansion locations so that movement takes place along axis of pipe only. Support guide from minimum two joists or beams.
- C. Install connections between piping mains and terminal units at least four (4) pipe fittings including tee in the main.
- D. Install expansion fittings according to manufacturer's written instructions. Install expansion fittings in sizes matching pipe size in which they are installed. Align expansion fittings to avoid end-loading and torsional stress.
- E. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- F. Attach pipe bends and loops to anchors:
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.2 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- D. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

3.3 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION 22 05 16

SECTION 22 05 19 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions, and other Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Floor Drains
- B. Backflow Preventers
- C. Cleanouts
- D. Shock Absorbers
- E. Hose Bibbs
- F. Non-Freeze wall hydrants (NFWH)
- G. Pressure gauges
- H. Strainers
- I. Silent check valve
- J. Flap valve
- K. Access valve boxes

1.3 RELATED WORK

- A. Division 22 – Common Work Results for Plumbing
- B. Division 22 – Plumbing Piping
- C. Division 22 – Pipe Insulation Building Plumbing System
- D. Division 22 – Plumbing Equipment

1.4 REFERENCES

- A. ANSI A112.21.1 - Floor Drains.

- B. ANSI A112.21.2 - Roof Drains

1.5 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01 and 22 – Common Work Results for Plumbing.
- B. Include component sizes, rough-in requirements, service sizes and finishes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - FLOOR DRAINS / SINKS

- A. J.R. Smith
- B. Zurn
- C. Wade

2.2 FLOOR DRAINS

- A. Type (A) Drains: ANSI A112.21.1: Duco-coated cast-iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round adjustable nickel-bronze strainer, trap primer connection, heel-proof strainer; Model 2005-A-HP-P050 manufactured by J.R. Smith.
- B. Type (B) Drains: ANSI A112.21.1: Duco-coated cast iron body with drainage flange, weep holes, clamping collar, trap primer connection, and round cast iron strainer. Provide plug for trap primer connection where not used. Provide deep seal P-trap with drains. Model 2230 manufactured by J.R. Smith.
- C. Type (A) Floor Sink: ANSI A112.21.1: Duco-coated cast iron body with drainage flange, acid resistant coated interior, weep holes, clamping collar, and aluminum dome bottom strainer, trap primer connection, nickel bronze rim and secured grate. Model 3150C-14 with grate and 2-1/2" square center hole as manufactured by J.R. Smith. The contractor shall either supply the grates with factory cut openings or shall carefully and neatly cut the required openings in the drain grates or approved equal.

2.3 SHOCK ABSORBER DEVICES

- A. Provide where indicated or required, shock absorbing devices which will protect water supply piping from water hammer. They shall be one of the following types and manufacturers:
 - 1. Sealed air chamber metal bellows type shall be Smith "Hydrotrol", Wade Mfg. Co., "Wade Wacor Shock Stop", or Zurn Mfg. Co. "Shocktrol".
 - 2. Elastic tube and insert type shall be Josam Mfg. Co., "Shock Absorber".
 - 3. Provide adequate support for shock absorbing devices, as approved, to prevent strain on piping.'

2.4 HOSE BIBBS, HOT AND COLD

2.5 STRAINERS (non-water meter use)

- A. Provide pipeline strainers at inlets to pressure reducing valves, temperature regulating valves, at other points where indicated.
- B. Strainers shall be Y pattern, full size of connecting pipe. Strainers screens shall be brass or other corrosion resistant metal with perforations as recommended by the manufacturer for the intended service. Strainer screens shall be removable without disconnecting any piping.
- C. Bodies on strainers 2 inches in size and smaller shall be bronze screwed design for 250 psi maximum pressure. Larger strainers shall have iron bodies designed for a working pressure of not less than 125 psi. Each strainer shall be provided with a brass plug.
- D. Strainers shall be Sarco, Leslie Co., or Power Regulator Co.

2.6 SILENT CHECK VALVE

- A. Wafer style silent check valves shall be of silent operating type that closes as flow is reduced and fully closes at zero velocity stopping reverse flow which reduces or eliminate water hammer stock.
- B. The valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to that of the pipe size.
- C. The valve shall operate equally well in the vertical or horizontal position with the flow up or down.
- D. All component parts shall be field replaceable and without the need of special tools. A replaceable guide bushing shall be provided and held in position by the valves spring. The cracking pressure shall be less than 1 psi.
- E. The valve disc shall be convex in sizes up to 6" and concave in 8" and larger to the flow direction providing for disc stabilization, maximum strength and a minimal flow velocity to open the valve.

- F. When specified, a rubber seal shall be furnished to provide a drip tight seal. The rubber seal shall be glued or chemically adhered.
- G. Ductile Iron valve bodies shall be coated inside and out with NSF/ANSI 61 certified fusion epoxy.
- H. The valve shall be equal in all respects to the Model 888/888R as manufactured by the Flomatic Corporation.
- I. Silent Check Valve Ordering Information is as followed:
 - 1. Quantity:
 - 2. Type: 888, ST, S6, 888R, STR & S6R
 - 3. Size: Available 2" thru 10"
 - 4. Body Material: Stainless Steel
 - 5. Internal Materials: Stainless Steel
 - 6. End Type: ANSI class 125# or 250#
 - 7. Seat Ring: Metal-to-Metal or Rubber

2.7 BACKFLOW PREVENTER DEVICES

- A. Install a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. Listed below is a partial list of connections to the potable water system which shall be protected against backflow or back siphonage.
- B. Reduced pressure backflow preventer:
 - 1. Incoming water service, connections to HVAC make-up water, pressure washer.
- C. Dual check backflow preventer:
 - 1. Water supply to ice makers, coffee makers, refrigerator and water coolers.
- D. Atmospheric Vacuum Breaker:
 - 1. Hose bibbs and sinks with threaded outlets.
- E. Anti-Siphon Vacuum Breakers shall be Model No. 288A, No. 84, No. NF8 as manufactured by Watts, or approved equal.
- F. Reduced-Pressure Zone Backflow Preventers (Incoming Domestic Water Service) shall be an ASSE 1047, FM approved, UL listed, and suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks, pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves and reduced-pressure backflow preventer. These units shall be Watts Model No. 909, Wilkins or Ames.
- G. Reduced pressure backflow preventers (HVAC make-up connections) shall be of bronze body construction, stainless steel internal parts and flange bolts, durable tight seating rubber check

valve assembly, suitable for supply pressure up to 175 psi and for water temperature up to 210 degrees F furnished complete with strainer, test cocks and ball valves and shall conform to A.S.S.E. Standard 1013, Series 009QT as manufactured by Watts Regulator Co., Wilkins or Ames

- H. The dual check backflow preventer shall meet the domestic requirements of ANSI/ASSE Standard 1024, and bear the seal of approval. It shall be bronze-bodied and include not less than one union, with the union nut drilled to accept a tamper-proofing lock wire. A brass identification tag indicating direction of flow shall be securely attached to the valve body by corrosion-resistant mechanical fasteners. The Lead Free* Dual Check Valve shall comply with state codes and standards, where applicable, requiring reduced lead content. The dual check shall be Watts Series LF7.

2.8 ACCEPTABLE MANUFACTURERS - CLEANOUTS

- A. J.R. Smith
- B. Zurn
- C. Wade

2.9 CLEANOUTS

- A. Interior Finished Floor Areas: Duco-coated cast-iron, two-piece body and adjustable nickel-bronze scoriated cover in service areas and square with depressed cover to accept floor finish in finished floor areas; Model 4020 and Model 4200 manufactured by J. R. Smith.
- B. Interior Finished Wall Areas: Line type with Duco-coated cast iron body and round epoxy coated gasketed cover, and round stainless-steel access cover secured with machine screw; Model 4452 manufactured by J. R. Smith.
- C. Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.10 ROOF STACK TERMINATION

- A. Provide sleeves for stacks passing through roof. Flashing around base of stack shall be under Division 07.

2.11 FLAP VALVE, FOR RPZ DRAIN TERMINATION AT EXTERIOR WALL, (SEE DRAWINGS)

- A. Duco Cast Iron Body with backwater flap valve. Back water valve flapper set at factory to hang in closed position. JR Smith model 7070 (basis of design), Zurn, or Wade.

2.12 PRESSURE GAUGES (SEE DRAWINGS)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate cutting of floor construction to receive drains to required invert elevations.

3.2 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Extended cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

3.3 CLEANOUTS, TEST TEES, ACCESS COVERS

- A. Each vertical soil, waste and vent pipe and each downspout and roof drainage pipe which connects to horizontal drain piping below ground shall be fitted with test tees installed above the ground or floor. Where accessible space is available test tees may be installed in the horizontal pipe at the base of the vertical pipe.
- B. Provide cleanouts where indicated and even if not indicated in the following locations.
 - 1. At points of change in direction of horizontal drains.
 - 2. At intervals of 50 feet in long horizontal drains of 4" diameter or less and no more than 80 feet apart for larger pipes.
 - 3. At ends of branch drains where possible.
 - 4. At or close to base of soil and waste stacks.
- C. Cleanouts shall be installed in locations which shall make them accessible for easy removal and which will provide clearance for rodding.
- D. All cleanouts shall be full size of pipe up to four inches (4") in diameter and four inches (4") for larger pipe size.

END OF SECTION 22 05 19

SECTION 22 05 29 – HANGERS & SUPPORTS FOR PLUMBING & EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section includes hangers, supports, anchors, sleeves, seals, flashing and sealing for mechanical system piping and equipment.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include:
 - 1. Division 05 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
 - 2. Division 21 Sections on fire-suppression piping for fire-suppression pipe hangers.
 - 3. Division 22 Section "Plumbing Systems Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 REFERENCES

- A. ASTM A 36/A 36M-00a: Specification for Carbon Structural Steel
- B. ASTM A 780-00: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- C. ASTM C 533-95: Specification for Calcium Silicate Block and Pipe Thermal Insulation
- D. ASTM C 552-00 (Revised 2001): Specification for Cellular Glass Thermal Insulation
- E. ASTM C 1107-99: Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- F. ASME B31.9-96: Building Services Piping
- G. 2001 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; Section IX, "Welding and Brazing Qualifications"
- H. AWS D1.1-00: Structural Welding Code – Steel
- I. MSS SP-58-93: Pipe Hangers and Supports – Materials, Design and Manufacture
- J. MSS SP-69-96: Pipe Hangers and Supports – Selection and Application

- K. MSS SP-89-98: Pipe Hangers and Supports – Fabrication and Installation Practices
- L. MSS SP-90-00: (Reaffirmed 1991): Guidelines on Terminology for Pipe Hangers and Supports
- M. MFMA-3-99: Metal Framing Standards Publication
- N. MFMA-102-99: Guidelines for the Use of Metal Framing
- O. SSPC-PA 1-2000: Paint Application Specification No. 1: Shop, Field and Maintenance Painting
- P. IAPMO PS 42-96: Pipe Alignment and Secondary Support Systems

1.4 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.5 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design seismic restraint hangers and supports for piping and equipment.

1.6 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pipe Hangers:
 - a. B-Line Systems, Inc.
 - b. Carpenter & Patterson, Inc.
 - c. Grinnell Corp.
 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. Unistrut Corp.
 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. Pipe Shields, Inc.
 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 2. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 2. Properties: Non-staining, noncorrosive, and nongaseous.
 3. Design Mix: 5000-psi, 28-day compressive strength.

2.4 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.5 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustable, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit hanger rods. Inserts not allowed on piping 2 inches and larger.

2.6 FLASHING

- A. Metal Flashing: 26 gauge galvanized steel.
- B. Lead Flashing: 5 lb./sq. ft. sheet lead for waterproofing; one lb./sq. ft. sheet lead for soundproofing.
- C. Flexible Flashing: Thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

2.7 SLEEVES

- A. Sleeves for Pipes: Schedule 10, black steel.
- B. Sleeves for Ductwork: 18 gauge, black steel.
- C. Fire Stopping Insulation: Glass fiber type, non-combustible.
- D. Caulk: Acrylic sealant.

2.8 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Provide copper plated hangers and supports for copper piping.

2.9 SEALS

- A. Mechanical Type; Inter-locking synthetic rubber links; pressure plates and compression bolts. Include sleeve from same manufacturer.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood inserts.
 6. Insert Material: Length at least as long as protective shield.
 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- L. Supports shall secure pipes in place, shall prevent pipe vibration, maintain required grading by proper adjustment, provide for expansion and contraction and shall make a neat appearance. Supports shall be of strength and rigidity to suit loading, service and installed in a manner in which will not stress unduly the building construction. Hangers shall not be permitted from roof and floor slabs. Fasten hangers and supports to building framing wherever practicable. Where required, add supplementary steel members to support piping. Hangers shall be capable of vertical adjustment after piping is erected. Hanger rods shall not pierce ducts.

1. Support horizontal piping of steel as per following schedule:

Pipe Size (Inches)	Rod Diameter (Inches)	Max. Spacing (Feet)
Up to 1-1/2	3/8	6
2 and 3	1/2	10
4 and 5	5/8	12
6	3/4	12
8, 10 and 12	7/8	14

For horizontal piping larger than 12 inches, support piping from building steel at point indicated on drawings.

2. Support horizontal copper tubing as per following schedule:

Pipe Size (Inches)	Maximum Spacing (Feet)
Up to 1-1/2	6
2 to 3	10
3-1/2 and larger	12

Rod diameter shall be the same as specified for steel pipe. Support plastic piping in accordance with manufacturer's published recommendations.

3. Vertical Piping Supports

- a. Cast Iron and Steel: Support at each floor with a maximum spacing of 20 feet and not exceeding eight feet from ends of risers, unless otherwise required by expansion conditions.
- b. Copper Tubing: Support at each floor and between floors by stays or bracing to prevent rattling and vibration, unless otherwise required by expansion conditions.
- c. Plastic and Glass: Support in accordance with published manufacturer's recommendations.
- d. Support vertical lines which rise from lowest story with base fitting set on concrete or brick pier, or by hangers located on horizontal connections to riser.
- e. Bolt pipe riser clamps securely to pipe; rest clamp and extension on building structure. In special cases where directed, weld clamp to pipe and to building steel. Where required, provide supplementary steel members for clamp rest.

3.3 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one-inch minimum into hub, 8 inches sheet clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk metal counter flash and seal.
- C. Seal floor, shower and mop sink drains watertight to adjacent materials.
- D. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flexible sheet flash and counter flash with sheet metal; seal watertight.

3.4 SLEEVES

- A. Provide sleeves at all pipe penetrations of floor and walls.

- B. Extend sleeves through floors one inch above finished floor level. Grout sleeves in place. Staff joint with fire stop insulation and caulk seal airtight.
- C. Duct penetrations of non-rated floors and walls shall have the edge joint stuffed with insulation and the caulk sealed, airtight. No sleeve is required.
- D. Duct penetrations of rated partitions and floor shall be sleeved with 12 gauge galvanized steel as per UL fire damper detail. Caulk all floor penetrations watertight between the floor and sleeve with fireproof caulk, airtight.
- E. Install chrome plated steel escutcheons at finished surface.
- F. Use mechanical seals at exterior wall pipe penetrations below grade.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.6 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.8 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Ceiling Plates: Where hanging rods or piping leave unsightly holes in ceilings in finished areas, provide plastic ceiling plates, Grinnell Figure 127 or cast iron ceiling plates with setscrew, Grinnell Figure 395.

END OF SECTION 22 05 29

SECTION 22 05 53-IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Access panel and door markers.
 - 3. Pipe markers.
 - 4. Valve tags.
 - 5. Valve schedules.
 - 6. Warning tags.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 REFERENCES

- A. ASTM C 1036-91 (Reapproved 1997): Specification for flat glass.
- B. ASTM D 709-92 (Reapproved 1997): Specification for laminated thermo-setting materials.
- C. ASME A13.1-96: Scheme for the identification of piping systems.

1.4 SUBMITTALS

- A. Submit product data.
- B. Submit list of wording, symbols, letter size and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function and valve manufacturer's name and model number. (also include maintenance manuals)
- D. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: comply with ASME A13.1, "Scheme for the Identification of Piping Systems", for letter size, length of color field, colors and viewing angles of identification devices for piping.

1.6 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Color: Unless specified otherwise, conform the ANSI/ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Plastic Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number and serial number.
 - b. Capacity, operating and power characteristics and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.

- d. Other design parameters such as pressure drop, entering and leaving conditions and speed.
 3. Size: 2-1/2 by 4 inches for control devices, dampers and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment. Markers for chemical fume or bio-hazard service shall be labeled accordingly.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe markers, General: Preprinted, color-coded, with lettering indicating service and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch-thick brass.
 2. Valve-Tag Fasteners: Brass S-hook.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of plumbing equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 1. Fuel-burning units, including boilers, water heaters, heaters, stills, and absorption units.
 2. Pumps, compressors, and similar motor-driven units.
 3. Heat exchangers, coils, heat recovery units, and similar equipment.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fire department hose valves and hose stations.
 - c. Meters, gages, thermometers, and similar units.
 - d. Fuel-burning units, including boilers, water heaters, heaters and stills.
 - e. Pumps, compressors and similar motor-driven units.
 - f. Heat exchangers, coils, and similar equipment.
 - g. Tanks and pressure vessels.
 - h. Strainers, filters, water-treatment systems, and similar equipment.
- C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 1. Pipes with OD, Including Insulation: Pre-tensioned pipe markers. Use size to ensure a tight fit.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches round.
 - b. Hot Water: 1-1/2 inches round.
 - c. Gas: 1-1/2 inches round.
 - d. Compressed air: 1-1/2 inches round.
2. Valve-Tag Color:
 - a. Cold Water: Natural
 - b. Hot Water: Natural
 - c. Gas: Natural
 - d. Compressed air: Natural
3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.
 - c. Gas: Black.
 - d. Compressed air: Black.

3.5 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 22 05 53

SECTION 22 05 83 - INSPECTION, TESTS, ADJUSTMENTS AND ACCEPTANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Standard General Conditions, and other Division-1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. The work included under this section of the specification consists of the furnishing of all labor, materials, equipment and service necessary to complete the inspections and testing of all plumbing and drainage work as shown on the drawings and as called for in these specifications.
- B. All work shall be tested to the satisfaction of the Architect/Engineer for leaks, faulty joints, improper operation and inefficiency. Provide test pump, gauges, meters, other instruments required in connection with tests.
- C. All equipment and piping shall be thoroughly cleaned of iron cuttings and other refuse during assembly, installation and before testing.
- D. Do not cover or paint any part of piping nor connect fixtures and equipment, before testing and obtaining approval.

PART 2 - PRODUCT – NOT USED

PART 3 - EXECUTION

3.1 GAS SUPPLY PIPING TEST

- A. After installation of gas piping, before connecting meter or appliances, test system for gas-tightness with compressed air or nitrogen. Test pressure shall be 1-1/2 times the proposed maximum working pressure, but not less than 3 psig. The duration of the test shall be one-half 1/2 hour for each 500 cubic feet of pipe volume, but not less than one-half hours.
- B. After connecting appliances and when ordered to turn on gas supply, check for leakage with meter; purge gas line; follow instructions in NFPA Pamphlet 54 in doing this.

3.2 DISINFECTION OF DOMESTIC WATER PIPING

- A. Prior to starting work, verify system is complete, flushed and clean.

- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C601.

3.3 DOMESTIC HOT WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated (Venturi tubes, orifices, or other metered) fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- D. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.4 SANITARY SYSTEM TEST

- A. The piping of plumbing drainage and venting systems shall be tested upon completion of the rough piping installation by water or air and proved water-tight. Where required by the code official, the cleanout plugs shall be removed to ascertain if the pressure has reached all parts of the system. Either of the following methods shall be used.
 - 1. Water Test: The water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping shall be closed except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be plugged except the highest opening of the section under test, and each section shall be filled with water, but a section shall not be tested with less than a 10-foot head of water.

In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested, so that a joint or pipe in the building (except the uppermost 10 feet of the system) shall not have been subjected to a test of less than a 10-foot head of water. The

water shall be kept in the system or in the portion under test for a minimum of 15 minutes before inspection starts. The system shall then be tight at all points.

2. Air Test: The air test shall be made by attaching an air compressor or testing apparatus to an opening, and, after closing all other inlets and outlets to the system, forcing air into the system until there is a gauge pressure of 5 pounds per square inch (5 psi/34.47 kPa) or a minimum of 10-inch column of mercury. This pressure shall be held without introduction of additional air for a minimum period of 15 minutes.

3.5 FINISHED PLUMBING TEST

- A. Where required by the code official, after the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight by one of the following test methods:
 1. Final test for gas and water-tightness: The final test for gas and water tightness of the completed drainage and vent system shall be made by a smoke test or other approved method. The test shall be made by filing all traps with water, and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be built and maintained for the period of the inspection.
 2. After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proven gas and water-tight by plugging the stack openings on the roof and building drain where the drain leaves the building, and with air introduced into the system equal to the pressure of a 1-inch water column. This shall be accomplished by the use of a "U" tube or manometer inserted in the trap of a water closet. Such pressure shall remain constant for the period of inspection without the introduction of additional air.

3.6 WATER SUPPLY SYSTEM TEST

- A. Upon completion of a section of or the entire water supply system, the system, or portion completed, shall be tested and proved tight under a water pressure not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source of supply.
- B. All plumbing fixtures, piping, valves etc. used for potable water (drinking and cooking) shall comply with "lead free" requirements as per NSF 61/372.
- C. The Contractor shall test the domestic water system both before and after providing plumbing fixtures, piping, valves etc. and shall be in compliance with the Department of Health lead in water regulation (10 NYCRR 67-4). Test results shall be submitted to SED prior to cutting into the domestic water system and final test results shall be submitted once all work is completed.

3.7 ADJUSTMENTS, REPAIRS, AND TESTS

- A. This Contractor shall adjust, repair and test the plumbing systems as specified herein.

- B. Correct defects disclosed by tests or inspection; replace defective parts when directed. In replacing defective parts use only new material; in case of pipe replace with same length as defective pieces. Caulking of screwed joints will not be permitted. Repeat tests after defects have been corrected and parts replaced, as directed, until pronounced satisfactory.
- C. The cost of repairs and restoration of work of other trades damaged by the tests, or cutting that had to be done in connection with test shall be made at no extra cost to the owner.

3.8 PERFORMANCE TESTS AND ACCEPTANCE

- A. Before final acceptance of the system, this Contractor shall test the various systems under normal conditions for one 8-hour day or longer when so directed to determine that they fulfill requirements of plans, specifications and they operate satisfactorily.
- B. Any defects made manifest by those tests shall be immediately and promptly made good after which the system shall be retested as required and/or directed.

3.9 INSPECTION

- A. The Contractor shall obtain all inspection required by laws, ordinances and regulations of the Village of Sydney and other authorities having jurisdiction. The Contractor shall obtain certificates of inspection and submit them to the Owner and shall pay for all fees, charges and other expenses in connection with the same, including same in Contract Price.
- B. This Contractor shall furnish and install such test tees and plug fittings in his work as may be required by local authorities for their test, and any other test required, and shall ascertain information from local authorities as to all requirements before installation of work. No claims for extension of time will be entertained which arises from failure to obtain this information in time, or securing the necessary permits and arranging for required inspection.

3.10 TRAINING

- A. Plumbing Contractor shall furnish qualified trained personnel for a period of 1 week minimum to properly instruct the Building personnel in all details of operation of the equipment installed under these specifications, and he shall supply personnel to operate them for a sufficient length of time to satisfy the Architect that the requirements of the drawings and specification have been fulfilled in all respects

END OF SECTION 22 05 83

SECTION 22 07 19-PIPE INSULATION BUILDING PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. The conditions as defined in Division 22, Common Work Results for Plumbing, shall apply to Division 22 of the specifications.
- B. This Contractor shall carefully read the above mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read, or attend to, any paragraph or items contained therein.

1.2 WORK INCLUDED

- A. Piping insulation.
- B. Jackets and accessories.

1.3 RELATED WORK

- A. Division 22 – Plumbing Scope of Work
- B. Division 22 – Common Work Results for Plumbing

1.4 SCOPE

- A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the following commercial piping systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract:
 - 1. Domestic hot water and domestic hot water recirculation and service hot water systems, 105° F (40° C) and up
 - 2. Domestic Cold Systems, 40° F (4.44° C) and up
- B. The above temperature ranges are typical for these systems. However, if contract specifications call for service temperatures outside the above ranges, consult the manufacturer's published data to determine operating temperature limitations of the insulation product or products under consideration.

1.5 REFERENCES

- A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
 - 1. American Society for Testing of Materials Specifications:
 - a. ASTM C 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation"
 - b. ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation"
 - c. ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
 - d. ASTM C 795, "Thermal Insulation for Use Over Austenitic Stainless Steel"
 - e. ASTM C 1136, "Standard Specification for Barrier Material, Vapor," Type 1 or 2 (jacket only)
 - 2. General Material Specifications:
 - a. ASTM E84 – Surface Burning Characteristics of Building Material.
 - b. NFPA 255 – Surface Burning Characteristics of Building Materials.
 - c. UL 723 – Surface Burning Characteristics of Building Materials.
- B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.6 DEFINITIONS

- A. The term "mineral fiber" as defined by the above specifications includes fibers manufactured of glass, rock, or slag processed from a molten state, with or without binder.

1.7 SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers' Association (NAIMA) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standards 90.1 (1989), "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:
 - 1. American Society for Testing of Materials ASTM E 84
 - 2. Underwriters' Laboratories, Inc. UL 723
 - 3. National Fire Protection Association NFPA 255

- C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos free characteristic.

1.8 QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.02 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.9 DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site.
- D. Applicator: Company specializing in piping insulation application with five (5) years minimum experience.
- E. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50 in accordance with ASTM E84.

1.10 SUBMITTALS

- A. Submit product data under provisions of Division 01 and 22.
- B. Include product description, list of materials and thickness for each service, and location.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

- A. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system. It shall be of a type suitable for installation on piping systems as defined in Section 1.4 SCOPE above.

Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547. One of the following types shall be used:

1. For indoor systems operating at temperatures from zero to +450° F (232° C):
 - a. Heavy density Fiberglass pipe insulation with factory applied all-service jacket (ASJ) and Doublesure* two-component adhesive closure system, rated for a maximum service temperature of 850° F (454° C). For large pipe sizes where SSL-II is not available, the single adhesive SSL closure may be substituted. Circumferential joints shall be sealed by butt strips having a two-component sealing system. Stapling is not required to complete the closure. When self sealing lap systems are used, sufficient thickness of insulation shall be used to maintain the outer surface temperature of the operating system below +150° F (65° C). Manufacturer's data regarding thickness constraints in relation to operating temperature shall be followed. When multiple layers are required, all inner layer(s) shall be unjacketed.

(*Trademark of Morgan Adhesive Company)

On cold systems, vapor barrier performance is extremely important. All penetrations of the ASJ and exposed ends of insulation shall be sealed with vapor barrier mastic.

If humidities in excess of 90% are expected, the ASJ shall be protected with either a mastic coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

2. For cold systems, operating either part or full time below ambient temperatures, but not less than zero F (-18° C):
 - a. Heavy density Fiberglass pipe insulation jacketed with ASJ but without the self-sealing lap may be used, provided all laps and butt strips are sealed with a contact adhesive or suitable vapor barrier mastic reinforced with glass fabric. All penetrations of the ASJ and all exposed ends of the insulation shall be sealed with vapor barrier mastic.

If humidity in excess of 90% is expected, the ASJ shall be protected with either a mastic coating or a suitable vapor retarding outer jacket unaffected by surface condensation. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

- B. For piping equal to or larger than 10" (25.4 cm) diameter, operating at temperatures up to +450° F (232° C) (or above), and where moderate abuse resistance is required, the following may be installed:
 1. Fiberglass pipe and tank insulation, heavy density mineral fiber insulation, maximum operating temperature of 650° F (343° C), end-grain factory-adhered to an ASJ all-service jacket. All joints shall be stapled, then (1) sealed with mastic or (2) closed with 3" (7.5 cm) pressure-sensitive tape matching the ASJ jacket.

- C. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of Fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be pre-formed PVC fitting covers or as otherwise specified on contract drawings.
1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor resistant mastic as dictated by the system location and service.
 2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
 3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems shall be sealed with caulking to allow free movement of the stem but provided a seal against moisture incursion.
- D. All piping shall be supported in such a manner that neither the insulation nor the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing shall be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier shall be continuous, including material covered by the hanger saddle.
1. Piping systems 3" (7.5 cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation.
 2. For hot or cold piping systems larger than 3" (7.5 cm) in diameter, operating at temperatures less than +200° F (93° C) and insulated with fiber glass, high density inserts such as wood or foam with sufficient compressive strength shall be used to support the weight of the piping system.
At temperatures exceeding +200° F (93° C), Owens-Corning Pink Calcium Silicate pipe insulation shall be used for high density inserts.
 3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7 kg/cm).
 4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
 5. Thermal expansion and contraction of the piping and insulation system can generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
 6. On vertical runs, insulation support rings shall be used as indicated on contract drawing.

2.2 ACCESSORY MATERIALS

- A. Accessory materials installed as part of insulation work under this section shall include (but not be limited to):
 - 1. Closure Materials – Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
 - 2. Field-applied jacketing materials – Sheet metal, plastic, canvas, fiberglass cloth, insulating cement; PVC fitting covers.
 - 3. Support Materials – Hanger straps, hanger rods, saddles.
- B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Standards."

PART 3 - EXECUTION

3.1 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PREPARATION

- A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 INSTALLATION

- A. General

1. Install all insulating materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
2. Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
3. Installation insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. But insulation joints firmly to ensure complete, tight fit over all piping surfaces.
4. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

B. Fittings

1. Cover valves, fittings, and similar items in each piping system using one of the following:
 - a. Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
 - b. Insulation cement equal in thickness to the adjoining insulation.
 - c. PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

C. Penetrations

1. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

D. Joints

1. Butt pipe insulation against hanger inserts. For hot pipes, apply 3" (7.5 cm) wide vapor barrier tape or band over butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3" (7.5 cm) wide vapor barrier tape or band.
2. All pipe insulation ends shall be tapered and sealed, regardless of service.

E. Vertical Piping

1. If specified on contract drawings, all insulated, exposed vertical piping within the building and all insulated piping exposed to the outdoors shall be additionally jacketed with 0.016" thick (0.6 mm) (minimum) aluminum. Vertical piping shall be protected to a height of 8'-0" (2.5 mm) above the floor.

3.4 FIELD QUALITY ASSURANCE

- A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.5 PROTECTION

- A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.
- B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.6 SAFETY PRECAUTIONS

- A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.
- B. The insulation contractor shall conduct all jobsite operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all State and Local safety and health codes and regulations that may apply to the work.

3.7 SCHEDULE: THICKNESS

MINIMUM PIPE INSULATION						
INSULATION THICKNESS FOR PIPE SIZES						
Piping System & Types	Fluid Temp Range	Less Than 1-1/2"	1-1/2" To 2"	2-1/2 To 4"	5 & 6 Inch	8" or Larger
Hot Water and Hot Water Recirculation	100-200	1.5	2.0	2.0	2.0	2.0
Low Temp Piping						
Cold Water, Condensate Drain and other Drain Lines	40-65	1.0	1.5	1.5	1.5	1.5
Rainwater Conductors	40-55	1.0	1.5	1.5	1.5	1.5

END OF SECTION 22 07 19

SECTION 22 10 00 – PLUMBING PIPING AND VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Pipe and pipe fittings for the various systems.
- B. Valves and cocks for the various piping systems.
- C. Sanitary sewer and vent piping system.
- D. Storm water piping system
- E. Domestic cold and hot water piping system.
- F. Painting of piping systems.

1.3 RELATED WORK

- A. Division 22 – Common Work Results for Plumbing
- B. Division 22 - Supports and Anchors
- C. Division 22 – Plumbing General
- D. Division 22 – Piping Insulation
- E. Division 22 - Plumbing Specialties
- F. Division 22 - Plumbing Fixtures
- G. Division 22 - Inspection, Tests, and Adjustments

1.4 REFERENCES

- A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- B. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

- C. ANSI/ASME Sec. 9 - Welding and Brazing Qualification.
- D. ANSI/ASTM B32 - Solder Metal.
- E. ANSI/AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- F. ANSI/AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
- G. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
- H. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- J. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- K. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- L. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- M. AWS A5.8 - Brazing Filler Metal.
- N. AWWA C601 - Standard Methods for the Examination of Water and Waste Water.
- O. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- P. 2020 Plumbing code of NYS with 2018 International Plumbing Code with amendments
- Q. 2020 Building code of NYS with 2018 International Building Code with amendments
- R. 2020 Fire code of NYS with 2018 International Fire Code with amendments
- S. NFPA Codes (latest editions)
- T. All State and Local rules and regulations.

1.5 QUALITY ASSURANCE

- A. No welder shall be employed who has not been fully qualified and certified by an approved, nationally certified, welding bureau or similar recognized testing agency.
- B. The competent and experienced welders who have qualified shall be retained at the job at all times when welding is done. Once qualified they shall not be removed from the job. Each welder shall be in possession of a stamp to identify work performed by him.

- C. Welding material and labor shall be in accordance with the welding procedures of ANSI piping codes, A.P.I. (American Petroleum Institute), ASME Code and in accordance with requirements set forth in "Welding of Pipe Joints" of the "Code for Pressure Piping: and in accordance with the American Welding Society Welding handbook. Mark of welder shall be stamped on each welded joint of pipe.
- D. Install piping systems to meet the requirements of all applicable state and local codes.
- E. Each length of pipe or fitting furnished shall be marked with the manufacturer's name, brand and specification code designator to which it conforms.
- F. All above ground pipe and fittings to be painted shall be bare or coated with an easily removed mill primer, while pipe and fittings to be insulated shall be provided with a regular mill preservative primer with insulation applied over this.
- G. Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 SUBMITTALS

- A. Submit product data under provisions of Division 22- Common Work Results for Plumbing.
- B. Submit type of pipe, valves and fitting to be used for each service specified; obtain approval before installing.
- C. Pipe supports, hangers and inserts:
 - 1. Submit bulletins, catalog figure numbers or samples, as may be requested, of supports, hangers, inserts, wall seals, etc., proposed to be used for various conditions; obtain approval before installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products on site under provisions of Division 22 – Common Work Results for Plumbing.
- B. Properly protect all piping so as to prevent damage to the pipe or the introduction of foreign material into the pipe.
- C. Cap or plug all openings in pipe and pipe fittings during installation.
- D. During loading, transportation and unloading, use care to prevent injury to pipes and pipe fittings. Do not drop pipe or fittings. Examine all pipe and fittings before laying. Do not install any piece that is found to be defective.
- E. Store and protect all materials from injury prior to installation. Do not store any materials directly on the ground or floor. Keep materials as clean and dry as possible and free from damage or deteriorating elements.

- F. Remove and replace with sound pipe, any defective pipe and pipe fittings discovered after installation without additional expense to the Owner.

PART 2 - PRODUCTS

2.1 SOIL, WASTE AND VENT PIPING

- A. Cast iron soil pipe and fittings, ASTM A74 and/or CISPI 301, service weight or extra heavy, shall be used for pipe buried in or in contact with earth within the building and to a point 5 feet outside of the building. Cast iron soil pipe and fittings, service weight, may be used for piping above ground where space within partitions involved can accommodate greatest diameter of pipe without any dimension deviations from the contract drawings. Pipe shall be bell and spigot, modified hub or plain end (no hub) as required by selected jointing method, except plain end (no hub) shall not be used below ground.

All cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

1. Joints: Provide one of the following types to suit pipe furnished:
 - a. For bell and spigot soil pipe, joints shall be packed with pure picked oakum, fill with molten lead at one pouring to a depth of one inch measured back from the face of the bell, caulk solid flush with hub rim.
 - b. For modified hub, joints shall be double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed. Dual-service gaskets will not be accepted.
 - c. Joints for no-hub cast iron soil pipe and fittings shall consist of a neoprene gasket conforming to ASTM C-564 and stainless steel clamps series 300.
 - d. Where no-hub is used, anchors shall be provided at the water closets to prevent pipe from twisting.
 - e. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leak proof joints.
 2. Coating: Provide a heavy coat of asphalt or bitumastic paint on pipe buried in earth or installed in cinders or concrete construction.
- B. Steel pipe and fittings, except if optional material is provided, shall be used for piping above ground including equipment exhaust vents.
 1. Pipe shall be galvanized steel Type E, electric resistance welded; Grade A, standard weight and shall conform to ASTM a-53.
 2. Fittings:
 - a. Soil and waste water piping fittings shall be galvanized special heavy cast iron recessed long turn and banded drainage type and shall meet the requirements of ASTM A-126.

- b. Sanitary and exhaust vent pipe fittings shall be galvanized malleable iron meeting requirements of ASTM A-197. Couplings may be standard couplings furnished with pipe.
- C. Copper tube: May optionally be used for piping above ground except urinal drains.
 - 1. Copper tubing shall be types "L", "K" or "DWV" seamless or use with solder type fittings and shall meet the requirements of ASTM B-88.
 - 2. Fittings: Shall be cast bronze recessed drainage type.
 - 3. Joints shall be 50-50 solid core solder using No. 50 noncorrosive flux for non-portable water only.
 - 4. Propress or similar type systems are also acceptable.

2.2 STORM WATER PIPING

- A. Cast iron storm water pipe and fittings, ASTM A74 and/or CISPI 301, service weight or extra heavy, shall be used for pipe buried in or in contact with earth within the building and to a point 5 feet outside of the building. Cast iron storm water pipe and fittings, service weight, may be used for piping above ground where space within partitions involved can accommodate greatest diameter of pipe without any dimension deviations from the contract drawings. Pipe shall be bell and spigot, modified hub or plain end (no hub) as required by selected jointing method, except plain end (no hub) shall not be used below ground.
 - 1. Joints: Provide one of the following types to suit pipe furnished:
 - a. For bell and spigot soil pipe, joints shall be packed with pure picked oakum, fill with molten lead at one pouring to a depth of one inch measured back from the face of the bell, caulk solid flush with hub rim.
 - b. For modified hub, joints shall be double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed. Dual-service gaskets will not be accepted.
 - c. Joints for no-hub cast iron soil pipe and fittings shall consist of a neoprene gasket conforming to ASTM C-564 and stainless steel clamps series 300.
 - 2. Coating: Provide a heavy coat of asphalt or bitumastic paint on pipe buried in earth or installed in cinders or concrete construction.
- B. Steel pipe and fittings, except if optional material is provided, shall be used for piping above ground.
 - 1. Pipe shall be galvanized steel Type E, electric resistance welded; Grade A, standard weight and shall conform to ASTM A-53.
 - 2. Fittings:
 - a. Storm water piping fittings shall be galvanized special heavy cast iron recessed long turn and banded drainage type and shall meet the requirements of ASTM A-126.

2.3 UNDERGROUND WATER PIPING

- A. From inside face of exterior wall to a point 5 feet outside building, underground inside building, and Fire Service main connection, materials shall be as follows:
 - 1. Water piping 3 inches and larger shall be ductile iron, Pressure Class 350, Thickness Class 52, pressure rated for 350 psi, and shall meet requirements of AWWA C-151. The outside shall be coated with bitumastic enamel and the inside cement lined. Provide flanged and anchored connection to interior piping. Fittings to be AWWA C153/A21.53 or AWWA C110/A21.10-08 rated for the same pressure.

2.4 INTERIOR WATER PIPING

- A. Pipe: Shall be copper tubing type "L", seamless for use with solder type fittings and shall meet the requirements of ASTM B-88. The name or trademark of the manufacturer and mark indicative of the type shall be marked permanently on each tube at intervals not greater than 4-1/2 feet.
- B. Fittings for copper tube shall be wrought copper or cast bronze solder joint type and couplings for jointing tube ends shall have center stops.
- C. Adapters: Provide adapters for jointing screwed pipe to copper tubing.
- D. Solder shall be lead-free, having a lead composition equal to or less than 0.2 percent lead and shall conform to ASTM B-32 for hot and cold water supply piping.

2.5 EXPOSED WATER AND WASTE PIPING

- A. Finished Rooms: use full iron pipe size chrome plated brass piping connecting fixtures and equipment when not concealed by apron including those specified in other sections.
 - 1. Pipe shall be seamless and meet the requirements of ASTM B-43 except that the minimum proportion of copper shall be 85 percent.
 - 2. Fittings shall be cast brass chrome plated screwed. For waste, fittings shall be drainage pattern.
 - 3. All exposed water and waste piping shall be painted. Color by Architect. See painting specification for paint type/application.

2.6 NIPPLES

- A. All pipe nipples installed throughout this work shall be extra heavy pipe of the same material as the pipe line in which installed.

2.7 UNION AND FLANGES

- A. Provide unions, screwed or flanged, where indicated and in following locations, even if not indicated.

1. In by-pass around equipment.
 2. In connections to pumps, and other equipment requiring disconnections for repairs, replacement, locate between shut-off and equipment. Do not conceal unions in walls, partitions or ceilings.
 3. In drainage piping only on inlet side of fixture trap.
- B. Unions 2 inches and smaller in lines of copper tubing shall be standard weight, all brass, ground joint, for solder type connections. When installed in brass or copper lines, they shall have ends for screwed connections. When installed in iron or steel lines, they shall be of the screwed malleable pattern suitable for 150 pounds water pressure. They shall be of the ground type with brass seat ring. The brass seat ring shall be pressed into the headpiece so that it cannot be pulled or forced out.
- C. Unions 2-1/2 inches and larger in lines of copper tubing shall be standard weight, flanged pattern, gasket type, all brass, for solder type connections. When installed in iron or steel lines, they shall be standard weight, screwed cast iron flanged pattern, gasket type, black or galvanized to suit the piping which they are installed.
- D. Brass flanged union connections shall be made up with brass bolts and nuts, galvanized unions with iron bolts and nuts and black flanged unions with black bolts and nuts.
- E. Flanges shall be of the same weight as fittings in same service category; drilled for 125 psi as required.
- F. Screwed flanges shall be cast iron. Welding flanges shall be steel welding neck type.

2.8 GASKETS

- A. Gaskets for pipe flanges shall be ring type, 1/16 inches thick, of compressed non-asbestos fiber and special compound, suitable for service intended, factory cut for flange size, similar to Durable Manufacturing Company, "Durably", Garlock, Inc. "Garlock 961", or approved equal.

2.9 WALL SEALS

- A. Provide mechanical wall seals in exterior walls below grade and other locations requiring lead caulking. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall opening. The seal shall be watertight between the pipe and wall opening. The seal shall be constructed so as to provide the electrical insulation between the pipe and wall, thus reducing the chances of cathodic reaction between these two members.
- B. The pipe to wall penetration closures shall be "Link-Seal" as manufactured by Thunderline Corporation, Livonid, Michigan.

2.10 SLEEVES AND ESCUTCHEONS

- A. Provide galvanized steel pipe sleeves for pipe passing through concrete beams, outside walls, foundations, footings and waterproofed floors, unless brass sleeves or wall seals are specified.
- B. Provide brass pipe sleeves for piping passing through terrazzo or ceramic tile floors.
- C. Provide galvanized No. 26 gauge sheet steel sleeves with lock seam joints for pipes passing through floors, interior walls and partitions. Sleeves shall not be installed in dry wall construction.
- D. Sleeve flashing shall be 16 ounce soft sheet copper, or a 4 pound lead flashing.
- E. Escutcheons shall be one piece with set screw except where otherwise noted, constructed of the following material:
 - 1. Chrome plated cast brass for chrome plated piping.
 - 2. Nickel plated cast iron for piping passing through toilet rooms.
 - 3. White painted sheet brass or steel for pipes passing through white prefinished ceilings.
 - 4. Cast iron, deep cup type for sleeves that project above finished floor.
 - 5. Heavy, solid pattern steel or cast iron with set screw for all other piping.

2.11 HANGERS AND SUPPORTS

- A. Products of Grinnell, B-Line Systems Inc., or Basic Engineering Inc., will be acceptable in place of a particular manufacturer's catalog figure number specified herein.
- B. Overhead supports: Provide one of the following types of hanger for overhead support of horizontal piping:
 - 1. For copper tubing where hangers are in direct contact with tubing, use clevis type steel hanger, copper plated, Grinnell Fig. CT-65, with supporting rod to suit.
 - 2. For all other piping 4 inches and smaller, use slevis type hangers, Grinnell Fig. 260.
 - 3. Hangers for hot water piping, where provisions for expansion and contraction is required, pipes over 4 inches shall be single pipe roll type hangers with two rods and adjustable sockets; Grinnell Fig. 171 or split single roller hanger with one rod, Grinnell Fig. 174.
 - 4. Provide supporting rods for hangers of diameter as indicated and where not indicated, as specified under "Horizontal Pipe Supports Schedule" hereinafter, of lengths as required, with double lockouts for each.
 - 5. For large piping on rollers as indicated, provide pipe roll stand constructed of cast iron Grinnell Fig. 271.
 - 6. Where indicated, provide adjustable pipe supports from the floor. Support shall consist of a cast iron saddle with a factory assembled adjusting nipple and reducer. Grinnell Fig. 395.
- C. Where hanger rods leave unsightly holes in ceilings in finished areas, provide plastic ceiling plates, Grinnell Fig. 127 or cast iron ceiling plates with setscrew, Grinnell Fig. 395.

- D. Wall Supports: Provide one of the following to support horizontal piping from wall.
1. Where no provision for expansion and contraction is required and pipe can be located close to wall, use steel J-hook, suitable for pipe sizes up to 3 inches, Grinnell Fig. 126.
 2. For hanger suspension, 750 lb. maximum loading, use light welded steel bracket with hole for one rod up to 3/4 inch diameter, Grinnell Fig. 194. For additional rod suspension, use with this bracket steel clip Fig. 193 for pipe sizes up to 3 inches.
 3. For pipe roll stand support, use welded steel bracket, light for 750 pound maximum loading Grinnell Fig. 194, medium for 1500 maximum loading Fig. 195, heavy for 3000 pound maximum load Fig 199.
- E. Vertical Piping Supports:
1. Where hangers are in direct contact with copper tubing, use copper tubing riser clamps Grinnell Fig. CT-121. For steel piping at intermediate floors, use steel extension pipe clamps, Grinnell Fig. 261.
- F. Clamps:
1. Where beam clamps are required on piping 6 inches and smaller, use malleable iron "C" clamp with case hardened cup pointed setscrew and retaining strap; Grinnell Fig. 87. On piping 8 inches and larger, fasten hanger to structure with adjustable beam clamp. Grinnell Fig. 292.
- G. Concrete Inserts:
1. Concrete inserts shall be black malleable iron universal type for threaded connection with lateral adjustment, stop slot for reinforcing rods, lugs for attaching to forms, Grinnell Fig. 282.
- H. Pipe Covering Protection:
1. On hot and cold water piping, provide galvanized steel pipe shields of length and thickness to distribute the piping load over the insulation at each support when pipe is erected, with support segment thickness equal to adjoining insulation when load applied, Grinnell Fig. 167.
 2. Bottom half of insulation shall be rigid polyurethane foam insulation having a 4 pound density and a compressive strength of 125 psi. Top half of insulation shall be of specified insulation.
- I. Roof Piping Supports:
1. Where piping is run on building roofs or other similar locations, provide roller supports models 6-RAH-12 series, 5-SB-H series and 6-H single and/or dual clevis models to suit the installation height. All supports shall be adjustable in height to accommodate the desired installed height as well as the pitch of the roof. Install in accordance with the manufacturer's installation requirements.

2.12 ACCEPTABLE MANUFACTURERS – GATE VALVES

- A. Nibco
- B. Stockham
- C. Crane
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.13 GATE VALVES

- A. Up to 2 Inches: Bronze body, rising stem and handwheel, inside screw, single wedge or disc, solder ends.
- B. Over 2 Inches: Iron body, epoxy coated wetted surface conforming to NFS 61, bronze trim, rising stem and handwheel, OS&Y, solid wedge, flanged ends.

2.14 ACCEPTABLE MANUFACTURERS – BALL VALVES

- A. Nibco
- B. Stockham
- C. Crane
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing

2.15 BALL VALVES

- A. Up to 2 inches: Bronze body, standard port, stainless steel ball, teflon seats and stuffing box ring, lever handle, solder ends with union. Rated at 175 psig minimum.
- B. Over 2 inches: Cast steel body, chrome plated steel ball, standard port, teflon seat and stuffing box seals, lever handle, flanged. Rated at 175 psig minimum.

2.16 ACCEPTABLE MANUFACTURERS – FULL PORT BALL VALVES

- A. Nibco
- B. Stockham
- C. Crane
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.17 FULL PORT BALL VALVES

- A. Up to 2 inches: Bronze body, full port, stainless steel ball, teflon seats and stuffing box ring, lever handle, solder ends with union. Rated at 175 psig minimum.
- B. Over 2 inches: Cast steel body, chrome plated full port steel ball, teflon seat and stuffing box seals, lever handle, flanged. Rated at 175 psig minimum.

2.18 ACCEPTABLE MANUFACTURERS – SWING CHECK VALVES

- A. Nibco
- B. Stockham
- C. Crane
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.19 SWING CHECK VALVES

- A. Up to 2 Inches: Bronze 45 degree swing disc, screwed ends.
- B. Over 2 Inches: Iron body, epoxy coated wetted surface conforming to NFS 61, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.

2.20 ACCEPTABLE MANUFACTURERS – BALANCING VALVES

- A. Bell & Gossett, Circuit Setter Plus
- B. Taco
- C. Autoflow Incorporated
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.21 BALANCING VALVES

- A. Furnish and install as shown on plans and with manufacturers recommendations, Bell & Gossett, "Circuit Setter Plus", Model CB calibrated balance valves.
- B. Pre-Set Balance Feature - Valves to be designed to allow installing contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with pre-set balance schedule.
- C. Valve Design and Construction - All valves 2" to 3" pipe size to be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential read-out ports across valve seat area. Read-out ports to be fitted with internal EPT insert and check

valve. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated name plate to assure specific valves settings. Valves to be leak-tight at full rated working pressure.

- D. Preformed Insulation - All valves to be provided with molded insulation to permit access for balance and read-out.
- E. Design Pressure Temperature
 - 1. 1/2" - 3" NPT connections 300 psig at 250° F.
 - 2. 1/2" and 3/4" sweat connections 200 psig at 250° F.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scales and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. All piping shall be installed so as not to interfere with any electrical lighting outlet which must be accurately centered and located. Special attention shall be given to this provision regarding piping on ceilings which must be kept a sufficient distance from the outlets to permit the installation of the lighting fixtures and their reflectors. The mechanical trades shall consult with the electrical trades for exact locations of fixtures and equipment.
- H. Arrange and install piping approximately as indicated straight, plumb, and as direct as possible, form right angles on parallel lines with building walls. Keep pipes close to walls, partitions and ceilings, offset only where necessary to follow walls, as directed.

- I. Locate groups of pipes parallel to each other and space them at a distance to permit applying full insulation and to permit access for servicing valves. Risers shall not have couplings in runs from one floor outlet to the next.
- J. Concealed piping:
 - 1. Where so indicated or specified, conceal piping in building construction or underground. Install such piping in time so as not to cause delay to work of other trades and to allow time for tests and approvals; do not cover before approval is obtained.
 - 2. Where furred spaces are indicated, keep pipes as close to structural members as possible so as to require minimum furring; in case of furred beams, obtain approval of resulting headroom clearance before installing pipe. This contractor is cautioned to check clearance on General Construction Drawings.
- K. Pipes over electrical equipment:
 - 1. Avoid running piping in Electric Equipment Rooms and Elevator Machine Rooms.
- L. Establish elevations of buried piping outside the building to ensure not less than 5'-0" of cover.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc primer to welding.
- N. Prepare pipe, fittings, supports and accessories not prefinished, ready for finish painting. Refer to Division 01.
- O. Establish invert elevations, slopes for drainage to 1/8inch per foot minimum unless otherwise noted on contract documents. Maintain gradients.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Install valves with stems upright or horizontal, not inverted.

3.3 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Make all joints watertight and gas tight under pressure required for various services.
- C. For threaded pipe joints, use only an approved pipe joint compound or teflon tape; apply only on male threads. Cut pipe nipples evenly; cut threads, clean, remove burrs, ream ends to full inside bore. Teflon tape shall be used in systems 150 degrees F and lower.
- D. All changes in direction and intersections of all welding piping shall be made with welding fittings. Mitering of pipe to form elbows and notching straight runs to form tees will not be permitted. Provide full size tees when branch lines are same size as main or one pipe size smaller. On mains 2-1/2 inches and larger having branch connections at least 2 sizes smaller than main threadolets, weldolets, saddle tees or welding tees may be used. On mains 2 inches and smaller full size tees shall be used.

- E. Install unions downstream of valves and at equipment or apparatus connections.
- F. Provide unions, screwed or flanged, where indicated and in following locations even if not indicated.

3.4 DRAINAGE PIPING INSTALLATION

- A. Where changes in pipe sizes occur, use only reducing fittings. For drainage piping changes in direction, use long sweep bends where possible, otherwise short sweep 1/4 bends or combination Y and 1/8 bends, also Y's or in combination with other bends, use sanitary T. branches only for horizontal branches discharging to stacks.
- B. Where waste lines from fixtures are indicated on plans to be acid resistant, vents shall be also be acid resistant.
- C. Soil, waste and storm water piping shall not pitch less than 1/8 inch per foot unless otherwise indicated.

3.5 EXHAUST AND RELIEF VENT PIPING INSTALLATION

- A. Extend exhaust vents separately through the roof. Sanitary vents shall not connect to exhaust vents.
- B. Provide relief vent piping for relief valves, receivers, etc., as indicated.
- C. Pipe size shall be such that cross sectional area is equal to the sum of the areas of the discharge connections of relief valves.
- D. Terminate vent piping so as to avoid injury to life or property.

3.6 INTERIOR WATER PIPING INSTALLATION

- A. Each branch from a main line shall be valved with a gate valve and each individual fixture shall be so valved that it can be readily shut off without interrupting the service to any other fixture or apparatus, fixture shut-offs being required for this purpose.
- B. All piping shall be installed to drain to low points where 2 inch male hose connections are to be installed.
- C. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixtures. Connect branch lines to top of main serving only fixtures. Connect branch lines to top of main serving only fixtures located on floor above.
- D. Provide swing connections throughout system to allow adequate horizontal and vertical expansion and contraction.

3.7 PIPE JOINTS

- A. Make all joints watertight and gastight under pressure required for various services.
- B. For threaded pipe joints, use teflon (R) tape, oil or approved pipe joint compound: apply only on male threads. Cut pipe nipples evenly; cut threads, clean, remove burrs, ream ends to full inside bore.
- C. For soldering or sweating joints on copper tubing, clean and polish outer surface of tube ends and inner surface of fittings, apply flux and solder as specified. The use of self-cleaning flux is prohibited. Copper tubing and fittings 2 inches and larger shall be tinned prior to making solder joint. A circular torch shall be used for soldering joints 2 inches and larger.

3.8 MECHANICAL PIPE COUPLINGS

- A. Couplings for steel pipe shall be self-centering and shall engage and lock in place the grooved or shouldered pipe and pipe fitting ends in a positive watertight couple.
- B. Coupling housing clamps shall be fabricated in two or more parts of malleable iron castings. Housing clamps shall hold in place a composition water-sealing gasket designed so that internal water pressure serves to increase the seal's water-tightness. Coupling assembly shall be securely held together by two or more track-head, square or oval neck steel bolts.
- C. Pipe fittings used in connection with pipe couplings shall have grooved or shouldered ends and shall be fabricated of malleable iron castings.
- D. Pipe fittings used in accordance with pipe coupling manufacturer's recommendations. Piping may be cut-grooved or rolled-grooved, except that pipe wall thickness, less than the minimum recommended by manufacturer, for cut-grooving shall be rolled-grooved without removal of any metal.

3.9 ELECTROLYSIS CONTROL

- A. The installation of copper tubing shall be accomplished in such a way as to not touch or come in contact in any way with ferrous metals.
- B. Where copper tubing or fittings are anchored, supported or may come in contact with metal construction, an insulation non-conductor spacer, similar to rubber, fiber or an approved equal, shall be installed to assure prevention of electrolysis.
- C. Hangers supporting copper tubing shall be copper coated and large enough to accommodate the insulating pipe covering. Copper tubing lines shall not be (even temporarily) supported or secured to ferrous metals.
- D. When copper piping or tubing is connected to ferrous piping or equipment, it shall be done with the use of a dielectric union or fitting.

- E. For connection of copper tubing to ferrous metal pipe, install dielectric union type fittings with non-conducting material in contact with both pipe materials, screwed or flanged, as manufactured by EPCO Sales, Inc., or approved equal.
- F. Samples of fittings shall be submitted to the Engineer for approval.

3.10 PIPES OVER ELECTRICAL EQUIPMENT

- A. Where pipe joints or valves in water lines occur within two feet in horizontal directions from electrical panels, equipment, provide drip pans of size which will afford protection as approved.
- B. Pans shall be 20 oz. sheet copper, edges turned up 2-1/2 inches all sides, reinforced with brass angles or by rolling edges over 1/4 inch diameter brass wire.
- C. Provide drain with 3/4 inch brass flange and copper tube to drain to nearest floor drain.
- D. Support the brass or angles, brace to prevent sagging or swaying as directed.
- E. No piping carrying water shall be installed in Electric Room.
- F. No piping shall be run in the dedicated equipment space as defined in the N.E.C. (NFPA 70). The dedicated equipment space is the space equal to the width and depth of the equipment and extending from the floor to a height of 6ft. Refer to the National Electrical Code section 110.26 (E) for further information. No piping, ducts, sprinklers, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone. It is this contractor's responsibility to coordinate with the electrical contractor for all phases of this project.

3.11 HANGERS AND SUPPORTS

- A. Supports shall secure pipes in place, shall prevent pipe vibration, maintain required grading by proper adjustment, provide expansion and contraction and shall make a neat appearance.
- B. Supports shall be of strength and rigidity to suit loading, service and installed in manner which will not stress unduly the building construction.
- C. Where support is from concrete construction, take care not to weaken concrete or penetrate waterproofing.
- D. Fasten supports, hangers, to building steel framing wherever practicable. Where required, add supplementary steel members to support piping.
- E. Use inserts for suspended hangers from concrete slab.
- F. Hangers shall be capable of vertical adjustment after piping is erected.
- G. Hanger rods shall not pierce ducts.

- H. Horizontal piping hanger spacing shall conform to the applicable plumbing code for this project. Where required, provide supplementary steel members for hanger attachment at the required intervals.
- I. Vertical piping supports:
 - 1. Cast iron and steel: Support at each floor with a maximum spacing as listed in the applicable plumbing code, and not exceeding eight feet from ends of risers, unless otherwise required by expansion conditions.
 - 2. Support vertical lines which rise from lowest story with base fitting set on concrete or brick pier, or by hangers located on horizontal connections to riser.
 - 3. Bolt pipe riser clamps securely to pipe; rest clamp and extension on building structure. In special cases where directed weld clamp to pipe and to building steel. Where required, provide supplementary steel members for clamp rest.
 - 4. Vertical piping support spacing shall conform to the applicable plumbing code for this project.
- J. Concrete Inserts:
 - 1. Where concrete inserts are required for pipe, ducts, hanging radiation supports, perform as follows:
 - a. Furnish and set inserts in concrete forms in ample time to permit pouring of concrete as scheduled; provide reinforcing rods for pipe sizes over 3 inches and for duct sizes as directed.
 - b. In areas where concrete slab forms finished ceiling, take care to have inserts finish flush with concrete slab surface; make appearance neat.
- K. Pipe Covering Protection
 - 1. Hangers and supports for piping testing on toilets shall not injure or pierce insulation.
 - 2. Hangers and supports shall be placed on the outside of the insulation.

3.12 EXPANSION REQUIREMENTS

- A. All piping shall be installed throughout the project with due regard for expansion to prevent damage to the building, equipment and piping. Provide anchors, loops or approved type expansion joints where indicated or required for the accurate control of movement.
- B. Bullhead connections in any piping service are prohibited.
- C. Provide adequate expansion allowance for service temperatures and piping materials.
- D. When installing piping with loop or bend expansion, submit piping to cold spring, which will take care of about half of total expansion between hot and cold conditions. Radiation branch connections shall have strain on when cold, off when hot. Make riser offsets in manner to avoid pocket forming due to expansion.

3.13 ANCHORS AND ALIGNMENT GUIDES

- A. Steel pipe anchors shall be made of minimum 1/4 inch "T" shape steel members. Anchors shall be welded to the pipe along the long axis. The top point of the "T" shall be welded to building steel. Submit detail drawings for approval before installation.
- B. Anchor pipe couplings shall be used on steel piping system for pipe 3 inch and smaller.
- C. Provide pipe alignment guides to guide the expanding pipe to move freely from anchor points in expansion joints, loops or bends. Submit detail drawings for approval before installation.

3.14 UNION AND FLANGES

- A. Provide unions, screwed or flanged, where indicated and in following locations even if not indicated.
 - 1. In bypass around equipment.
 - 2. In connections to pumps, traps and other equipment requiring disconnections for repairs, replacement, locate between shutoff and equipment. Do not conceal unions in walls, partitions or ceilings.

3.15 WALL SEALS

- A. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and Link-Seal to assure a watertight joint. If pipe O.D. is nonstandard due to coating, insulation, etc., consult factory for assistance and recommendation before proceeding with all opening detail.
- B. In lieu of providing fire stopping materials between sleeves and pipes in fire partitions and floors, the contractor may use the wall seals having a fire rating.

END OF SECTION 22 10 00

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SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Standard General Conditions, and other Division 01 Specification Sections, apply to this Section.
- B. Lead testing in school drinking water - NYSDOH,10 NYCRR Subpart 67-4.

1.2 WORK INCLUDED

- A. Electric Water Cooler (with bottle filler)

1.3 RELATED WORK

- A. Division 22 – Custom Casework: Preparation of counters for sinks.
- B. Division 22 – Joint Sealers: Seal Fixtures to walls and floors.
- C. Division 22 – Toilet and Bath Accessories: Lavatory tops.
- D. Division 22 – Food Service Equipment
- E. Division 22 – Anchors and Supports
- F. Division 22 – Common Work Results for Plumbing
- G. Division 22 – Plumbing General
- H. Division 22 – Plumbing Piping
- I. Division 22 – Plumbing Specialties
- J. Division 22 – Plumbing Equipment

1.4 REFERENCES

- A. ANSI A112.6.1 – Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ANSI A112.18.1 – Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI A112.19.2 – Vitreous China Plumbing Fixtures

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- D. ANSI A112.19.5 – Trim for Water-Closet Bowls, Tanks, and Urinals.
- E. ANSI Z124.2 – Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
- F. ARI 1010 – Drinking Foundations and Self-Contained Mechanically Refrigerated Drinking Water Coolers.

1.5 QUALITY ASSURANCE

- A. Fixtures: By same manufacturer for each product specified throughout.
- B. Trim: By same manufacturer for each product specified throughout.

1.6 SUBMITTALS

- A. Submit product data under provisions of Division 01 and 22 – Common Work Results for Plumbing.
- B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 22 – Common Work Results for Plumbing.
- B. Include fixture trim exploded view and replacement parts lists.

1.8 WARRANTY

- A. Provide three year manufacturer's warranty under provisions of Division 22 – Common Work Results for Plumbing.
- B. Warranty: Include coverage of electric water cooler compressor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – FIXTURES

- A. Kohler
- B. American Standard
- C. Elkay

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- D. Just
- E. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.2 ACCEPTABLE MANUFACTURES – FIXTURE TRIM

- A. Kohler
- B. Chicago Faucet
- C. T & S Brass

2.3 ACCEPTABLE MANUFACTURERS – FIXTURE CARRIERS

- A. J.R. Smith
- B. Zurn
- C. Wade
- D. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.4 ACCEPTABLE MANUFACTURERS – EMERGENCY PLUMBING FIXTURES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide emergency plumbing fixtures manufactured by Bradley Corporation, Menomonee Falls, WI 53051, (800)272-3539, fax (262)251-5817; Email info@BradleyCorp.com; Website www.bradleycorp.com.
- B. Substitutions: Under provisions of Division 22 – Common Work Results for Plumbing.

2.5 CARRIERS AND CARRIER FITTINGS

- A. Wall-hung urinals shall be supported independently of the wall by cantilever type chair carrier with cast iron foot support, pipe-uprights, steel supporting plate and lower bearing plate with rigid bearing studs that provide thrust to maintain clearance between bottom of urinal and finished wall. J.R. Smith Series No. 0635.
- B. Vitreous china lavatories (Regular and Handicapped) with back shall be supported independently of the wall by Series No. 0700-27-M31 Lavatory Chair carrier with cast iron foot support, pipe upright, concealed arms provided with non-slip type vandal proof locking device to prevent lateral movement of the lavatory.
- C. Floor mounted, rear outlet water closets shall be supported as follows:

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1. When single or back-to-back installations occur, connections shall be made with J.R. Smith Series No. 0675 or 0688 vertical offset waste.

2.6 SINK TAG D-1

- A. Sink: Type 304, 18-8 stainless steel, double bowl - ADA, 33" x 22" x 6" deep, three-hole, center drain in each bowl, thoroughly sound deadened, self-rimming, 8" centers, Model LRAD332260 manufactured by Elkay.
- B. Trim: ASME A112.18.1 chrome plated faucet with swing spout and rotating aerator; model K-7776-K faucet with K-16012-5 wrist blade handles as manufactured by Kohler.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

2.7 SINK TAG E-1

- A. Sink: Type 304, 18-8 stainless steel, single bowl - ADA, 17" x 16" x 6" deep, three-hole, center drain in each bowl, thoroughly sound deadened, self-rimming, 8" centers, Model LRAD171660 manufactured by Elkay.
- B. Trim: ASME A112.18.1 chrome plated faucet with swing spout and rotating aerator; model K-7776-K faucet with K-16012-5 wrist blade handles as manufactured by Kohler.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

2.8 UTILITY w/SIDEBORD (DOUBLE COMPARTMENT) TAG F

- A. Sink: Type 304, 14 gauge stainless steel, floor mounted single compartment, 50" x 31" x 14" deep, three-hole, center drain in each compartment, buffed satin finish, tubular stainless steel legs with bullet shaped feet adjustable up to 1". Sink shall be model number xxxxx as manufactured by Advanced Tabco.
- B. Trim: Chicago Faucets No. 510-GVB613L15XKCAB, Pre-Rinse Fitting with 613-A Adapta-Faucet, wall-mounted with adjustable arms for 7-1/4" - 8-3/4" centers. Chrome plated. Water conserving pre-rinse spray valve, 1.0 GPM @ 60 PSI. 2-3/8" metal, vandal-proof, lever handles with sixteen-point, tapered broach and secured blue and red index buttons. Ceramic quarter-turn cartridge with integrated check valve, features square, tapered stem. 3/8" offset inlet supply arm with 1/2" NPT female thread inlet. 2-5/16" diameter slip flange. 23" riser with spring guide. 44" flexible stainless steel hose with insulated handle. E23JKABCP in-line back flow preventer to prevent the flow of contaminated water back into the potable water supply. Pipe strap and hook assembly. NOTE: Atmospheric vacuum breaker is NOT intended for continuous pressure

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applications. ECAST™ construction with less than 0.25% lead content by weighted average. Full-flow Quixtop outlet with single-screen design. 2-3/8" metal, vandal-proof lever handle with sixteen-point, tapered broach and secured, white index button. Quatern^a re-buildable compression cartridge, opens and closes 90°, closes with water pressure, features square, tapered stem. This product is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, and NSF/ANSI 372 Low Lead Content.

- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

2.9 UTILITY (SINGLE COMPARTMENT) TAG G

- A. Sink: Type 304, 14 gauge stainless steel, floor mounted single compartment, 33" x 27 1/2" x 14" deep, three-hole, center drain in compartment, buffed satin finish, tubular stainless steel legs with bullet shaped feet adjustable up to 1". Sink shall be Sturdibilt Stainless Steel model number SS81302 as manufactured by Elkay.
- B. Trim: Chicago Faucets No. 510-GVB613L15XKCAB, Pre-Rinse Fitting with 613-A Adapta-Faucet, wall-mounted with adjustable arms for 7-1/4" - 8-3/4" centers. Chrome plated. Water conserving pre-rinse spray valve, 1.0 GPM @ 60 PSI. 2-3/8" metal, vandal-proof, lever handles with sixteen-point, tapered broach and secured blue and red index buttons. Ceramic quarter-turn cartridge with integrated check valve, features square, tapered stem. 3/8" offset inlet supply arm with 1/2" NPT female thread inlet. 2-5/16" diameter slip flange. 23" riser with spring guide. 44" flexible stainless steel hose with insulated handle. E23JKABCP in-line back flow preventer to prevent the flow of contaminated water back into the potable water supply. Pipe strap and hook assembly. NOTE: Atmospheric vacuum breaker is NOT intended for continuous pressure applications. ECAST™ construction with less than 0.25% lead content by weighted average. Full-flow Quixtop outlet with single-screen design. 2-3/8" metal, vandal-proof lever handle with sixteen-point, tapered broach and secured, white index button. Quatern^a re-buildable compression cartridge, opens and closes 90°, closes with water pressure, features square, tapered stem. This product is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, and NSF/ANSI 372 Low Lead Content.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.

2.10 Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons. SINK TAG J

- A. Sink: Type 304, 18-8 stainless steel, single bowl, 22" x 19 1/2" x 5 1/2" deep, three-hole, center drain in each bowl, thoroughly sound deadened, self-rimming, 8" centers, Model LRAD221955PD manufactured by Elkay.

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- B. Trim: ASME A112.18.1 chrome plated faucet with swing spout and rotating aerator; model K-7776-K faucet with K-16012-5 wrist blade handles as manufactured by Kohler.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

2.11 EMERGENCY EYE / FACE WASH PLUMBING FIXTURES TAG H

- A. Accessible, Plumbed Emergency Halo Stainless Steel Eye-Face Wash and Bowl Unit model number S19224SS. Complies with ANSI/ISEA Standard Z358.1, self-draining, with separate supply and waste piping. Provide factory-assembled and tested units with standard-compliant identification sign and inspection tag.
 - 1. Basis of Design Manufacturer/Model: Bradley, Wall-Mount Halo Accessible Eyewash S19224SS Series (stainless steel).
 - 2. Eyewash: 5.1 gpm (0.321 L/s) impact resistant ABS plastic sprayhead.
 - 3. Ball Valves: Shower valve and eyewash valve, chrome-plated brass stay-open eyewash valve and self-closing shower valve.
 - 4. Valve Operation: Hand-activated push handle and accessible pull rod.
 - 5. Pipe and Fittings: Type 304 stainless steel.
 - 6. Bowl: Type 304 Stainless steel with integral strainer.
 - 7. Dust Cover: Eyewash cover.
 - 8. Water Tempering Equipment: Thermostatic mixing valve assembly TMV#02.
 - 9. Scald Protection Equipment: Anti-scald valve.
 - 10. Flow Switch Alarm: 120 VAC, 1.75A
- B. Thermostatic Mixing Valve for Combination Shower Units TMV#02: ANSI Z358.1 compliant single valve design with liquid-filled unit-mounted dial thermometer, providing 85 deg F (29 deg C) tepid, potable water, maintaining temperature at plus or minus 5 deg F (3 deg C) for required 15-minute test period, and in case of unit failure to continue cold-water flow, with associated corrosion-resistant housing and fittings.
 - 1. Basis of Design Manufacturer/Model: Bradley, Navigator Emergency Thermostatic Mixing Valve S19-2000.
 - 2. Supply Connections: Hot and cold water.
 - 3. Flow Capacity: 7.3 gpm at 30 psi
 - 4. Finish: Chrome-plated bronze.
 - 5. Cabinet: Surface mounted stainless steel.

2.12 SINK TAG J-1

- A. Sink: Type 304, 18-8 stainless steel, single bowl - ADA, 19" x 18" x 6" deep, three-hole, center drain in each bowl, thoroughly sound deadened, under mount, 8" centers, Model LRAD191860 manufactured by Elkay.

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- B. Trim: ASME A112.18.1 chrome plated faucet with swing spout and rotating aerator; model K-7776-K faucet with K-16012-5 wrist blade handles as manufactured by Kohler.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

2.13 SINK TAG K-1

- A. Sink: Type 304, 18-8 stainless steel, single bowl - ADA, 19" x 18" x 6" deep, three-hole, center drain in each bowl, thoroughly sound deadened, self-rimming, 8" centers, Model LRAD191860 manufactured by Elkay.
- B. Trim: ASME A112.18.1 chrome plated faucet with swing spout and rotating aerator; model K-7776-K faucet with K-16012-5 wrist blade handles as manufactured by Kohler.
- C. Waste: 1 1/2" I.P.S. cast brass adjustable p-trap with c.o. plug, tubing waste to wall & escutcheon, two LKPD1 Perfect Drains with strainers and tailpieces.
- D. Supplies: 3/8" I.P.S. flexible riser with wheel handle stops and escutcheons.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
- B. Verify adjacent construction is ready to receive rough-in work of this Section.

3.2 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with chair, carriers and bolts as required.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Division 1, color to match fixture.
- F. Mount fixtures to the following heights above finished floor:

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1. Water Closet:

- a. Standard - 15 inches to top of bowl rim
- b. *Handicapped - 18 inches to top of seat

*Flush valve for handicapped must have operator set on the wide side of the stall, not more than 44 inches above finish floor.

2. Urinal:

- a. Standard – 22 inches to top of bowl rim
- b. *Handicapped - 17 inches to top of bowl rim

*Flush valve for handicapped shall have the operator set no more than 44 inches above finish floor.

3. Lavatory:

- a. Standard - 31 inches to top of basin rim
- b. Handicapped - 34 inches to top of basin rim and 29 inches to bottom of the apron

4. Drinking Fountain:

- a. Standard - 40 inches to top of basin rim
- b. Handicapped - 36 inches to spout

5. Water Closet Flush Valves:

- a. *Standard - 11 inches minimum above bowl rim
- b. *Recessed - 10 inches minimum above bowl rim

*Not more than 44 inches above finish floor for handicapped use.

6. Shower Heads:

- a. Adult - 69.5 inches to bottom of head
- b. Handicapped - Shower spray unit with 60 inches of hose and hand held shower.
- c. Controls - 38 inches to 48 inches above finish floor

3.3 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion clean plumbing fixtures and equipment.

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BIDDING DOCUMENTS

- C. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.4 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with following table of minimum sizes for particular fixtures.

	Hot Water	Cold Water	Waste	Vent
Lavatory	1/2"	1/2"	1-1/2"	1-1/2"
Service Sink	1/2"	1/2"	3"	2"
Sink	1/2"	1/2"	1-1/2"	1-1/2"
Drinking Fountain	--	1/2"	1-1/2"	1-1/2"
Water Closet (Flush Valve)	--	1-1/2"	4"	2"
Water Closet (Tank Type)	--	1/2"	4"	2"
Urinal (Flush Valve)	--	3/4"	2"	1-1/2"

END OF SECTION 22 40 00

SECTION 23 00 00 - HVAC SCOPE OF WORK

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 REQUIREMENTS

- A. The conditions as defined in Division 23 – Common Work Results for HVAC, shall apply to all Division 23 specifications.
- B. This contractor shall carefully read the above-mentioned documents and study the drawings of all trades. He shall be responsible for neglect to read, or attend to any paragraph or items contained herein.

1.3 INTENT

- A. It is the intent of this specification and accompanying drawings to provide HVAC system, as specified herein and as shown on the contract drawings. The drawings show the general arrangement and extent of the work to be done. Exact location and arrangement of all components shall be determined as the work progresses. Plans are subject to such modification as may be necessary at the time of installation in order to meet construction conditions. Any adjustments shall be made by the HVAC Contractor, without extra charge.
- B. The project is to be completed during normal working hours.

1.4 WORK INCLUDED

- A. These specifications and accompanying drawings are intended to cover the furnishing by this Contractor of all labor, material and equipment of every kind necessary for the complete installation of the various systems and such other material and equipment as hereinafter specified and shall not be limited to the following:
 - 1. Remove and replace High School Pool Dehumidification Unit.
 - 2. Provide new diffusers and grilles in Weight Room.
 - 3. Provide new dryer vent in High School Laundry Room.
 - 4. Provide new boilers, pumps, venting, piping and controls in Masonville Building.
- B. The following items of work related to HVAC will be performed by others as follows:

1. The General Contractor shall provide all foundations and pads for equipment, paint all piping in finished areas, provide all base flashing on roof, build in all sleeves, unless otherwise noted.
2. The General Contractor shall furnish and install all access panels and doors of sizes required.
3. The General Contractor shall install all access panels furnished by the HVAC Contractor.
4. The Electrical Contractor shall do all power wiring for HVAC equipment.

1.5 WORK AS A SUBCONTRACTOR

- A. When the HVAC work is subcontracted, the exact scope of work may be limited or added to at the discretion of the General Contractor/Construction Manager. A subcontractor shall, therefore, verify the extent of his work with the General Contractor/Construction Manager.

1.6 RELATED WORK SPECIFIED ELSEWHERE

The following related work items are included in separate divisions and Sections as follows:

- A. General Requirements, Division 01.
- B. Roof – Division 07.
- C. Painting – Division 09.
- D. Fire Protection General Requirements – Division 21.
- E. Electrical – Division 26.

PART 2 - PRODUCTS

- A. As specified in the following related sections.

PART 3 - EXECUTION

- A. All HVAC systems shall be complete and fully operational.
- B. It is the intent of the Drawings and Specifications and the contractor's responsibility is to provide a complete code compliant workable system ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform to the intent, are to be considered a part of the Contract.

END OF SECTION 23 00 00

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 EXECUTION OF THE WORK

- A. These specifications call out certain duties of the HVAC Contractor and any Subcontractors. They are not intended as a material list of items required by the Contract. Any reference in these specifications and on the accompanying drawings to the Contractor, Mechanical Contractor, ATC Contractor, Mechanical HVAC Subcontractor, Subcontractor or abbreviation "M.C.", shall be construed to mean the Contractor responsible for all mechanical construction (Division 23) work for this project.
- B. This division of the specifications covers the HVAC systems of the project. It includes work performed by the mechanical trades as well as trades not normally considered as mechanical trades.
- C. Provide all items and work indicated on the Drawings and all items and work called for in this division of the specifications in accordance with the conditions of Contract (Division 01 General Requirements Documents). This includes all incidentals, equipment, appliances services, hoisting, scaffolding, supports, tools supervision, labor consumable items, fees licenses, etc., necessary to provide complete systems. Perform start-up and checkout on each item and system to provide fully operable systems.
- D. Comply with all provisions of the Contract Documents including the General Conditions, and Division 01 General Requirements of the specifications.
- E. Certain terms such as "shall, provide, install, complete, start-up" are not used in some parts of these specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.
- F. Examine and compare the HVAC Drawings with these specifications, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid the most stringent requirements must be included in said bid.
- G. Examine and compare the HVAC Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid.

- H. Install and coordinate the HVAC work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.
- I. It is the intent of the Drawings and Specifications to provide a complete code compliant workable system ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform to the intent, are to be considered a part of the Contract.
- J. These specifications are basically equipment, installation, and performance Specifications. Some installation details are indicated on the Drawings. Where these differ from the Specifications, apply the more stringent at time of bid. Upon award of bid, contact Architect/Engineer for definite instructions.
- K. All materials furnished by the Contractor shall be new and unused (temporary services are excluded) and free from defects.
- L. All products and materials shall be new, clean, free of defects and free of damage and corrosion.
- M. The exclusion from, or limitation in, the symbolism used on the Drawings or the language used in the Specifications for HVAC work shall not be interpreted as a reason for omitting the accessories necessary to complete any required system or item of equipment.
- N. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.
- O. All items of equipment or material shall be the product of one manufacturer throughout. Multiple manufacturers will not be permitted.
- P. Receive, inspect, store and install Owner-furnished equipment where Owner furnished equipment is supplied.

1.3 COORDINATION OF THE WORK

- A. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.
- B. Carefully check space requirements with other trades and the physical confines of the area to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings and the spaces within the existing building. Make modifications thereto as required and approved.
- C. No items foreign to the electrical system shall be run in the dedicated space of the electrical equipment. Dedicated space shall be defined as the width and depth of the equipment from the floor to the bottom of the structural ceiling. Foreign systems include but are not limited to ductwork, piping, sprinklers, drip trays, etc. Contractor shall be responsible to coordinate the locations of the dedicated spaces with electrical and other trades as required.

- D. Transmit to other trades all information required for work to be provided under their respective Sections in ample time for installation.
- E. Wherever work interconnects with work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.
- F. Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate, project and schedule work with other trades in accordance with the construction sequence.
- G. The locations of piping, control panels, diffusers and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- H. Exercise particular caution with reference to the location of panels, diffuser, grilles, sensors, thermostat, switches, etc., and have precise and definite locations approved by the Architect/Engineer before proceeding with the installation.
- I. The Drawings show only the general run of duct/piping and approximate location of outlets/termination. Any significant changes in location of routing, necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made. All such modifications shall be made without additional cost to the Owner.
- J. Obtain from the Architect/Engineer in the field, the location of such outlets or equipment not definitively located on the Drawings.
- K. Wherever the work is of sufficient complexity, prepare additional Detail Drawings to scale similar to that of the bidding Drawings, prepared on tracing medium of the same size as Contract Drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit for review Drawings clearly showing the work and its relation to the work of other trades before commencing shop fabrication or erection in the field.
- L. Contractor shall furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate his work with the work of other trades. No work shall be installed before coordinating with other trades.
- M. Coordinate with contractors for work under other Divisions of this specification for all work necessary to accomplish this contractor's work.
- N. Where service connections are required, to equipment provided by the Owner or by other trades, this Contractor shall verify the exact requirements for these connections prior to ordering any materials or laying out any work. Where there is a discrepancy between the equipment being furnished and that shown on the Contract Drawings, the Contractor shall notify the Architect/Engineer for direction. Failure to comply with this coordination shall not constitute a

reason for extra monies for equipment ordered or installed. Restocking charges will not be paid.

1.4 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.5 SUMMARY

- A. This section includes the general requirements that apply to the Mechanical and HVAC Contractor. Fire Protection and the Controls Contractor or Sub-Contractor.
- B. The following work is specified under other Divisions, unless otherwise noted or specified hereinafter:
 - 1. Painting except as herein specified shall be by the General Contractor under Division 09.
 - 2. Site Work, Divisions 31, 32 and 33.
 - 3. Concrete, Division 03.
 - 4. Roof, Division 07.
 - 5. Plumbing, Division 22.
 - 6. Electrical, Division 26.
 - 7. Installation of starters, contactors, thermal overload switches and remote push buttons, and connection of power wiring to motors, Division 26.

1.6 INTENT

- A. Requirements specified herein shall govern applicable portions of Heating, Ventilation and Air Conditioning.
- B. It is the intent of this specification and accompanying drawings to describe and indicate the general manufacture, erection and installation of the equipment and connection to same specified herein and shown on the drawings. It is not intended that the specifications and drawings describe and indicate each piece of equipment required for installation, for where items are intended or required for satisfactory installation and are considered to be the accepted practice of the trade, they shall be considered to be both specified and indicated. Drawings are diagrammatic in nature; for piping systems; water piping is tapped off the bottom of the pipe and steam and steam condensate piping is tapped off the top of the pipe; provide all tees, elbows and swing joints as required for hookup to coils or branch piping as required for this work whether they are indicated on the drawings or not. For ductwork systems, provide offsets at interference locations and/or where changes in ceiling heights require such offsets; offsets shall be smooth as possible and without the need for hard elbows; offsets shall minimize the elbow angle required which shall result in minimal static pressure gradients into the system.
- C. It shall be understood that the Contractor as hereinafter mentioned shall be the Mechanical Contractor unless specifically noted otherwise.

- D. The Contractor shall furnish all plant, labor and material necessary for the complete and satisfactory installation of all Mechanical work for this contract.
- E. The Contractor shall assume the entire responsibility for the materials, workmanship and satisfactory operation of the various mechanical systems, and other work as specified herein and/or as shown on the drawings.
- F. The Contractor shall schedule and coordinate all work in close cooperation with all trades working on this project.

1.7 DEFINITIONS

- A. Following definition of terms and expressions used in this section are in addition to listing given in Supplementary Conditions:

- 1. "Provide" shall mean "furnish and install" unless otherwise indicated.
- 2. "Herein" shall mean the contents of a particular section where this term appears.
- 3. "Indicated" shall mean "Indicated on contract drawings".
- 4. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- 5. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- 6. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- 7. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- 8. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- 9. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic
 - b. CPVC: Chlorinated polyvinyl chloride plastic
 - c. NP: Nylon plastic
 - d. PE: Polyethylene plastic
 - e. PVC: Polyvinyl chloride plastic
- 10. The following are industry abbreviations for rubber materials:
 - a. CR: Chlorosulfonated polyethylene synthetic rubber
 - b. EPDM: Ethylene propylene diene terpolymer rubber
- 11. For additional abbreviations see the Abbreviations and Symbols Drawings.

1.8 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall be responsible for establishing grades and elevations, and checking of all interferences, and shall verify all dimensions and locations in the field.

- B. Contract drawings for mechanical work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, ducts, piping and approximate sizes and locations of equipment outlets. Mechanical trades shall follow these drawings in layout of their work, consult general construction, structural and electrical drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed.
- C. The Contractor shall verify with the A/E before bidding any item of piping or piping arrangement which may be incomplete, incorrect or indefinite. After contract is let, the A/E's decision shall be final.
- D. All trades shall cooperate and confer with each other as to locations of their materials and equipment before erecting work, so as to avoid interference as much as possible, and in such a manner that will in no way retard progress of construction. In instances where interferences develop, the contractor shall relocate the work as required by the A/E regardless of which work was installed first.
- E. Where job conditions require reasonable changes to indicate locations and arrangement, make such changes without extra cost to Owner. This is not to be construed to permit redesigning of the various systems.
- F. Additional and supplementary drawings may, from time to time, be furnished, and the same, when made, are to constitute a part of the original contract. These drawings will be made to clarify the contract drawings and will not depart materially therefrom.
- G. The A/E specifically reserves the right, up to the time of roughing-in, to exactly define the position of the equipment to be installed and connected to and arrangement of these connections.
- H. Special attention is called to the contract drawings and specifications involving general construction, electrical work and details thereon. Bidders are notified to carefully scrutinize these documents for the details affecting the performance of the mechanical trades.

1.9 SCHEDULE OF WORK

- A. The Contractor shall schedule all of his work to conform to the Job Progress Schedule as submitted by the General Contractor or Construction Manager, and approved by the A/E.

1.10 PREMIUM TIME WORK

- A. The following work shall be performed at night or weekends other than holiday weekends, as directed and coordinated with the Owner:
 - 1. Tie connections to all existing systems.
 - 2. All work in the existing building finished space.

1.11 PROGRESS OF WORK

- A. The Contractor shall order the progress of his work so as to conform to the progress of the work of other trades and shall complete the entire installation as soon as the conditions of the building will permit. Any cost resulting from the defective or ill-timed work performed under this section shall be borne by the Contractor.

1.12 DELIVERY, STORAGE, PROTECTION AND HANDLING

- A. Deliver, store, protect and handle all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair. Any such repairs shall be subject to review and acceptance of the Architect/Engineer.
- B. Delivery of Materials: Delivery materials in manufacturer's unopened container fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- C. Storage of Materials, Equipment and Fixtures: Store materials suitably sheltered from the elements, but readily accessibly for inspection by the Architect/Engineer until installed. Store all items, susceptible to moisture damage, in dry, heated spaces.
- D. Protect materials and equipment according to the manufacturer's instruction. Protection shall include damage due to fire, water, rust, oxidation, sunlight (for UV sensitive materials), breakage of UV lights, etc.
- E. Following is in addition to Protection of Work and Property, General Requirements:
 - 1. Responsibility for care and protection of mechanical work rests with the Contractor until it has been tested and accepted.
 - 2. After delivery, before, during and after installation, protect equipment and materials against theft, injury and damage from all causes.
 - 3. Protective covers, skids, plugs, caps and coating shall be provided to protect equipment materials from damage during construction.
 - 4. All equipment and material shall be stored under cover and off the ground.
 - 5. For outdoor storage, protective covers of sheet plastic shall be provided. Covers shall be of gauge required for the area involved and shall be reinforced to withstand wind, rain, sleet and snow. Equipment and material shall be set on skids or platforms of sufficient height to avoid deterioration from spattering and ground water.
 - 6. Plug open ends of pipes when work is stopped to prevent debris from entering the pipes.
 - 7. Open ends of duct work shall be closed when work is stopped with temporary closures of sheet plastic taped in place on horizontal ducts and sheet metal caps with drip overhangs for ducts opening upward.
 - 8. Air handling system shall not be operated during the construction period.
 - 9. Coat polished or plated metal parts with Vaseline immediately after installation.
- F. The Contractor shall receive, properly house, handle, hoist, and deliver to proper location, equipment and other materials required for the contract.
- G. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect/Engineer and at no additional cost to the Owner.

1.13 INTERFERENCE WITH THE OWNER'S NORMAL OPERATION

- A. All work shall be performed in such a manner as not to interfere with the normal work operations in adjacent spaces or buildings.
- B. In no way shall the Contractor:
 - 1. Block or restrict the means of egress for adjacent spaces.
 - 2. Decrease the fire rating of walls, partitions, ceilings, doors or combination thereof of adjacent spaces or of means of egress.
 - 3. Interrupt safety systems or in any way adversely affect the safety of people or materials in adjacent spaces.
- C. The Contractor shall provide acoustical isolation of the work area via temporary doors, partitions, etc., adequate to allow normal work functions.
- D. The Contractor shall provide exhaust fans, dust proof temporary partitions and any containment measure required to prevent dirt, dust, or fumes from reaching adjacent work spaces.
- E. All personal traffic and material delivery shall be routed so as to absolutely minimize travel through adjacent work area.

1.14 VISIT TO SITE

- A. The Contractor shall visit the site and thoroughly acquaint himself with all existing conditions relative to type and source of service available. He shall verify location and extent of these services and consider routing, interferences and excavation required by the contract and any and all other difficulties that may be encountered.
- B. Submission of a proposal shall be construed as evidence that such an examination has been made.
- C. Failure to visit the site shall not constitute sufficient reason to warrant claims for extra monies for difficulties not apparent in the contract documents.

1.15 MANNING THE PROJECT

- A. The Contractor shall, upon initiation of construction, keep a suitable force of men on the site at all times in order to lace all sleeves, inserts, outlet boxes, fixtures and provide all other openings as are required for the satisfactory installation of equipment.

1.16 FEES AND PERMITS

- A. The Contractor shall secure all permits and pay all fees, required by local and state governing bodies, necessary to complete his phase of the construction. Failure to investigate all applicable payments before the bid submission shall not constitute grounds for additional monies from the Owner. The Owner shall be furnished with all certificates of approval.

- B. The Contractor shall provide insurance and bonding as required by the Building Owner or as stated in the General Conditions.

1.17 CODES AND STANDARDS

- A. The design, construction and installation of all materials and equipment shall be in compliance with the latest edition of all national, state and local codes or standards.
- B. The codes and standards referred to are minimum standards. Where the requirements of these specifications and the accompanying drawings exceed those of the codes and standards, the drawings and specifications shall be followed.

1.18 BASIS OF DESIGN

- A. The layout is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements and service connections required for these particular items have been considered in making the layout. The contractor may use the equipment of any manufacturer whose name is approved for substitution on that item of equipment after he had ascertained that all provisions of MATERIAL SUBSTITUTIONS will be complied with and that all required service connections will be made at no additional cost to the Owner.
- B. Manufacturers are listed for a quality assurance level only. Although a manufacturer is listed does not constitute compliance with the specification size, weight, functionality, capacity, noise, or performance levels. It is this contractor's responsibility to assure the proposed manufacturer has complete compliance with the Contract Documents, **prior to bidding**.
- C. Except where dimensions are shown, the drawings are diagrammatic and shall not be scaled. Exact location of fixtures, apparatus, duct work and piping shall be determined by dimensions on the site. Contractor shall refer to architectural plans and details for exact dimensions.
- D. The drawings indicate the locations of apparatus, fixtures, ductwork, and piping shall be followed as closely as possible. If before the installation it is found necessary to change the location to accommodate conditions at the building, such changes shall be made at no additional cost to the Owner, and as approved by the Architect/Engineer.
- E. Equipment requiring operation, service or maintenance during the life of the system shall be made easily accessible.
- F. Ductwork or piping shall not be run within 48" of switchboards, panelboards or motor control centers.
- G. No piping, ductwork to other HVAC items shall be run in the dedicated equipment space as defined in the N.E.C. (NFPA 70). The dedicated equipment space is the space equal to the width and depth of the equipment and extending from the floor to a height of 6ft. Refer to the National Electrical Code section 110.26 (E) for further information. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone. It is this contractor's responsibility to coordinate with the electrical contractor for all phases of this project.

- H. Use of open-flame devices in work shall be accompanied by fire extinguishing apparatus within 25 feet of work location. All work shall be done in accordance with the general construction requirements and fire watch procedures.

1.19 QUALITY OF MATERIALS

- A. Where a specific model and manufacturer of equipment is specified, the Contractor shall provide what is specified without substitution. Where specified as "or approved equal", the Contractor may substitute equipment except that the burden is upon the Bidder to prove such equality. If the Bidder elects to prove such equality, he must request the Architect's approval in writing to substitute such item for the specified item, stating the cost difference involved with supporting data, and samples, if required, to permit a fair evaluation of the proposed substitute with respect to quality, serviceability, warranty and cost.
- B. Where a specific model of equipment is specified along with an approval equal manufacturer, no substitution will be allowed. The Contractor shall submit one of the manufacturers listed.
- C. Final approval of competitive equipment is reserved by the Engineer when, in the Engineer's opinion, the equipment does not correspond to that specified.

1.20 MATERIAL SUBSTITUTIONS

- A. Material substitutions shall be allowed only where "or equivalent" is stated.
- B. Material substitution submittals shall, include complete description of the proposed substitute, the name of the material or equipment for which it is to be substituted, drawings, cuts, performance, test data and evidence that the proposed manufacturer or his established representative maintains a qualified service organization including spare parts and is available for competent service on short notice.
- C. Each bidder by submitting his bid represents that the proposal of such article, device, product, material, fixture, form or type of construction by name, make, catalog number of manufacturer which varies with the equipment specified shall be incorporated into the project without claims against the Owner for additional cost. The bidder shall be responsible for all additional costs incurred by others due to the substitutions.
- D. The Architect/Engineer shall have the final approval of all submitted substitutions.
- E. Manufacturers are listed for a quality assurance level only. Although a manufacturer is listed does not constitute compliance with the specification size, weight, functionality, capacity, noise, or performance levels. It is this contractor's responsibility to assure the proposed manufacturer has complete compliance with the Contract Documents, **prior to bidding**.

1.21 SUBMITTALS

- A. Product Data, Shop Drawings: Submit for approval by the authority having jurisdiction and the Owner's insurance underwriter.

B. Product Shop Drawing Submittal List:

1. Within thirty (30) days after date of execution of the Owner/Contractor Agreement, submit for review and acceptance, a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom this trade proposes to employ.
2. Any requests for substitutions of equipment or materials must be submitted and returned prior to submitting the Submittal List. Only specified or accepted manufacturers or suppliers shall appear on the Submittal List.
3. The complete Submittal List must be reviewed and accepted by the Architect/Engineer prior to submittal of Shop Drawings. No Shop Drawings will be processed without an accepted Submittal List.
4. The Submittal List shall include all material, systems, and equipment specified herein.

C. Approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

D. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed and approved the submittals.

E. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and shall clearly identify equipment being submitted.

F. Submittals shall be marked to show specification reference including the section and paragraph numbers.

G. Submit each section separately and include the following:

1. Information which confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Submittals on all pumps and fans shall be complete with performance curves marked with the design points.
3. Submittals on electrical equipment shall be complete with all power and control wiring diagrams.
4. Vibration isolators shall include operating weight and load distribution at each mounting point.

H. The Contractor agrees that failure of manufacturer's submittal to conform to the above will result in a manufacturer's disqualification on this project.

I. Submit samples as directed of items called for in the specifications; samples of the materials which the manufacturer will actually ship shall be submitted for approval after award of contract and properly labeled on this project.

1.22 COORDINATION DRAWINGS

- A. Detailed layout shop drawings on all systems as required in Division 01 – Project Coordination, Division 21, 22, 23, and 26, must be coordinated with field erection drawings for Architectural, HVAC, Plumbing, Fire Protection, and Electrical Systems by the respective contractors.
- B. Prepare coordination drawings for all areas by building, floor area and/or phase, of the project. Close attention should be implemented where limited space availability necessitates maximum utilization of space for efficient installation of different components.
- C. Mechanical, Electrical and Plumbing Prime Contractors are responsible to prepare coordination drawings to a Scale of $\frac{1}{4}'' = 1'-0''$ or larger; detailing major elements, components, and systems of mechanical and electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including but not limited to the following:
 - 1. Proposed locations of ductwork, piping, conduit, equipment, and materials.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - 4. Equipment connection and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire rated wall, floor, ceiling, and roof penetrations.
 - 7. Sizes and location of required concrete pads and bases.
 - 8. Valve stem movement.
 - 9. Sleeves.
- D. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Clearly define relationships between sleeves, piping, ductwork, conduit, ceiling grid, lighting, fire sprinkler, HVAC equipment and other mechanical, plumbing, and electrical equipment with other components of the building such as beams, columns, ceilings, and walls.
- E. Prepare reflected ceiling plans to coordinate and integrate installations of air outlets and inlets, light fixtures, communication systems components, sprinkler, and other ceiling mounted items.
- F. Resolve conflicts between trades, prepare composite coordination drawings and obtain signatures from all affected Prime Contractors on original composite drawings. Submit coordination drawings to the Architect/Engineer and Construction Manager for approval.
- G. Mechanical, Electrical and Plumbing Prime Contractors are to first submit their respective shop drawings for approval, to the Architect/Engineer, in order to make any necessary changes prior to going through the coordination process.
- H. Coordination drawings to be signed off by affected Contractors within 45 days of Notice to Proceed. A Coordination drawing timeline schedule shall be developed and tracked.
- I. The coordination drawings shall be coordinated with the construction and phasing schedule.

- J. The routing process will begin with the HVAC Contractor who shall take the lead in the coordination of their work with all affected trades.
- K. The HVAC Contractor shall prepare CAD drawings to be used as the basis for coordination drawings in all areas or as determined by the Construction Manager (Scale: ¼" = 1'-0" or larger). These drawings shall be completed in digital format. All architectural features shall be accounted for in preparation of this drawing; i.e., permanent, casework, interior columns, partitions, finish ceiling and height, lighting and roof elevations, etc. The HVAC Contractor will provide CAD files and drawings showing all of the approved ductwork. HVAC Contractor is to locate all piping with orange lines. Forward drawings to the Plumbing Contractor.
- L. The Plumbing Contractor is to locate the plumbing lines with blue lines and sprinkler lines and head locations with red lines, and resolve all conflicts and determine locations and elevations, and forward drawing to the Electrical Contractor.
- M. The Electrical Contractor to indicate all lighting fixtures, panels with associated clearances, duct banks, bus duct, conduit racks and all individual conduits 1 ½" and larger in with green lines, and resolve all conflicts and determine locations and elevations and forward to the General Construction Contractor.
- N. The General Construction Contractor will have the last coordination review. Provide overlaid coordination drawings for all General Construction work and resolve all conflicts. All architectural features shall be detailed clearly, i.e. permanent casework, interior columns, partitions, finish ceiling and roof elevations, etc. Provide a ceiling layout detailed coordination drawing showing ceilings, lights, diffusers, etc.
- O. Contractors to provide underground coordination drawings for all underground utilities; show exact location of piping stub ups, floor drains, etc. as required.
- P. Prime Contractors shall be responsible for all costs associated with creating CAD files.
- Q. All coordination meetings will be held in the Construction Manager's field office or as required by the Architect/Engineer. As each coordination drawing is completed, Contractors are to meet with the Construction Manager to review and resolve all conflicts on the coordination drawings. Contractors are required to distribute shop drawings, cut sheets and submittals to other Prime Contractors where appropriate. Approved coordination drawings will also be available for reviewing at the Construction Managers field office.
- R. All Contractors shall provide a hard copy of the coordination drawings for review by the Architect/Engineer.
- S. Once complete and signed off, the HVAC, Plumbing and Electrical Contractors will submit dimensioned wall and slab penetration drawings and housekeeping pad drawings to the appropriate parties.
- T. If the coordination drawing process is not complete, Mechanical, Electrical and Plumbing Contractors will provide wall penetration drawings to the General Construction Contractor no later than five (5) days prior to wall erection.
- U. All Prime Contractors must install the work in accordance with the coordinated drawings at no additional cost to the Owner. No additional compensation will be made for extra ductwork

offsets, piping and/or conduit or retrofit work due to improper component location, or lack of Contractor(s) coordination.

- V. All Prime Contractors shall take special care in verifying with the Electrical Contractor that the equipment matches the characteristics of the power being supplied. The Electrical Contractor is similarly bound.
- W. The Mechanical, Electrical and Plumbing Drawings are schematic in nature and are not intended to show every offset and detail. The Mechanical, Electrical and Plumbing Contractors will make adequate provisions in their bid to accommodate the actual conditions, provide all required ductwork, piping and conduit offsets per the coordination drawings, without additional cost to the Owner.
- X. The Mechanical, Electrical and Plumbing Contractors shall hang streamers from all above ceiling equipment that will require access. This is in addition to any specification requirements for tags, labels, etc. Shop drawings should also highlight these areas for Architect/Engineer's review. In addition, the Contractors shall notify the Construction Manager and Architect/Engineer of all areas where equipment maintenance access is difficult. Coordinate architecturally placed access doors with points of mechanical/electrical systems requiring that access.
- Y. Specific Requirements – Required Information to be provided on Coordination Drawings:
 - 1. General Construction/Structural Work Information including but not limited to:
 - a. Openings and sleeve locations required in slabs, walls, beams, and other structural elements, including required openings not indicated on the Contract Documents.
 - b. Slab edge locations
 - c. Embed locations, as described above. Note embedded steel angles at edges of sump and sewage ejector pits, to accept basin covers.
 - d. Wall and chase spaces for housing HVAC, Plumbing, or Electrical items.
 - e. Access doors in coordination with the respective contractor systems.
 - f. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
 - 2. HVAC Work Information including but not limited to:
 - a. Sizes and bottom elevations of rectangular ductwork, including angle bracing, flanges, and support systems.
 - b. Sizes and centerline elevations of round ductwork, piping and conduit runs
 - c. Acoustical lining in ductwork.
 - d. Identification of ductwork pressure class.
 - e. Dimensions of major components, such as dampers, valves, diffusers, registers, cleanouts, coils, VAV boxes, HVAC equipment, and electrical distribution equipment.
 - f. Fire-rated enclosures around ductwork.
 - g. Access panels required.
 - h. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.

3. Plumbing and Fire Protection Information including, but not limited to:
 - a. Sizes and centerline elevations of piping runs.
 - b. Locations of plumbing valves, equipment, and fixtures.
 - c. Locations of standpipes, floor control assemblies, fire hose valves, mains, piping, branch lines, pipe drops, sprinkler heads, fire pumps/controllers, and jockey pumps.
 - d. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
4. Electrical Work Information including, but not limited to:
 - a. Runs of vertical and horizontal conduit, 1 1/4" diameter and larger
 - b. Light fixture locations
 - c. Exit light locations
 - d. Smoke detector and other fire alarm locations
 - e. Panelboards, switchboards, switchgear, transformers, busways, generators and motor control center, exit signs, and emergency battery pack locations.
 - f. Locations of pull boxes and junction boxes, dimensioned from column centerlines
 - g. Access panels required.
 - h. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
5. Ceiling Systems and Plenum Space Information including, but not limited to:
 - a. For HVAC, Plumbing, Fire Protection, Fire Alarm, Electrical, Controls and Telecommunications Work penetrating acoustical ceilings, show locations of each item (including sprinkler heads, diffusers, grilles, access doors, light fixtures, smoke detectors exit signs, speakers, and other visible ceiling mounted devices) relative to the acoustical ceiling grid.
 - b. Locate components within ceiling plenums to accommodate layout of light fixtures indicated on Drawings. Clearly indicate areas of conflict between light fixtures and other components on Coordination drawings.
 - c. Other specific/critical conditions unique to this Project, not noted above but necessary to assure proper coordination.
 - d. Materials within plenums shall be non-combustible or shall be listed and labeled as having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723. All materials located in plenums shall conform to International Mechanical Code.
- Z. The Sheet Metal Contractor shall prepare his work on reproducibles and submit 1/4" scale CAD drawings of the sheet metal duct field erection shop drawings for the coordination procedures, and each Contractor will supply the necessary qualified personnel for these procedures which will be conducted by the General Contractor. The HVAC, Plumbing and Fire Suppression work to the drawings where conflicts are noted and achieve solutions to any conflicts that may exist.
- AA. The General Contractor will be required to signify his acceptance of the results of the coordination procedures by signing and dating the master coordination print.

- BB. Each Contractor will be required to correct his field erection drawing(s) used as a basis for the coordination procedures to complement the results of the procedures prior to submitting same for approval. No field erection shop drawings will be accepted for approval without having been coordinated.
- CC. As part of the coordination procedures, applicable "Approval" or "Approved as Noted" copies of other trades' shop drawings will be transmitted to the Contractor. It will be each Contractor's responsibility to check these shop drawings to ascertain what effect, if any, these shop drawings have on that portion of the work under his direct responsibility. Each contractor will advise the General Contractor within forty-eight (48) hours of receipt of the shop drawings, in writing, indicating receipt of same and whether or not they have any effect on the work of his contract.

1.23 ELECTRICAL

A. Power Wiring

- 1. For the purpose of this specification, power wiring shall be defined as follows:
 - a. All wiring from the power source panelboards (or switchboard) to the disconnect switch to the equipment, and final connection to the equipment.
 - b. All power wiring to transformers serving VAV/CV boxes.
 - c. All wiring to control panels as indicated in the Electrical and Mechanical Contract Documents. (All control panels not indicated on the Electrical Contract Documents as receiving power shall do so by jumpers from other control panels, this wiring shall be considered control wiring as defined below).
- 2. All power wiring from the power source to the above noted switches and wiring from these switches to the equipment, including final connection to same, shall be provided under Division 26, Electrical.

B. Control Wiring

- 1. All other wiring required, whether line voltage or low voltage, internal or external to provide for the operation of the equipment shall be considered as control wiring. This shall include power wiring from transformers serving VAV/CV boxes and dampers at exhaust fans; wire to damper and fan end switch to starter.
- 2. All control wiring throughout the building, including wiring installed at piping, in ductwork, or as specified shall be provided under this Division.

- C. The Contractor shall furnish all motors, mounts, motor starters and remote mounted push-button controls for all electrically operated equipment furnished as part of the contract. The Contractor shall furnish all safety disconnects where described hereinafter. The Contractor shall furnish all speed control switches for all multi-speed motors. All motors shall have copper windings. (Aluminum windings will not be acceptable).

- D. This Contractor is completely responsible for the coordination with all other trades as to the correct voltage for all equipment requiring power. Equipment and or changes required to meet the project voltages will be the responsibility of this contractor.

- E. All push-button switches and starters shall be mounted under Division 26, Electrical.

- F. The Contractor shall provide all controls and control devices, all mounting for controls and all other electrical devices as specified and necessary for the complete installation and satisfactory operation of all electrically operated controls furnished under this Division.
- G. All locally mounted starters shall be furnished under Division 23, except as noted below. Where indicated hereinafter, starters shall be furnished as an integral part of equipment. Starters furnished in motor control centers shall be provided in Division 26, Electrical (refer to Electrical Drawings). Control of starters in motor control centers feeding mechanical equipment shall be provided under Division 23.
- H. Starting equipment of each motor shall be of the proper voltage and HP rated for the motor it is to serve. All starters shall be of the enclosed type; NEMA Type 1, for general-purpose enclosures; NEMA Type 4 for watertight enclosures, and NEMA Type 12 for the dust-tight enclosures. Location of motor shall determine type of enclosure to be used.
- I. Manual motor starters for single-phase motors shall be one or two poles as required, consisting of a snap switch combined with a thermal overload device. It shall be impossible for the switch to be held in a closed position under a sustained motor overload. For resetting the overload mechanism, the switch lever shall be of a design where it has to be moved to the "off" position. Starter shall be enclosed in type of enclosure for area in which it is to be used.
- J. Magnetic starters for 3-phase motors shall be furnished with 110 volt holding coils, 120 volt fused transformers, normally open and normally closed auxiliary contact and overload relay heater elements in all three phases. Provide hand/off/auto selector switch along with running status lights and external reset button.
- K. Locate starters and associated starter controls in accessible locations wherever possible. Location of starters for roof mounted exhaust fans and mechanical equipment above ceilings shall be located at accessible locations above ceiling. Locations shall be coordinated with furniture and equipment layouts for the optimum accessible location for installation and maintenance means.
- L. The Contractor shall be completely responsible for the coordination of automatic temperature control system with control interlocks between various items of mechanical equipment.

1.24 SCAFFOLDING

- A. The Contractor shall furnish and install scaffolding, ladders and runways required in connection with his work.

1.25 TEMPORARY OPENINGS

- A. Temporary openings not indicated, which may be required for purpose of bringing equipment into building, shall be as approved. General Contractor will perform work of providing and maintaining openings, and of restoring structure; but Contractor for whom temporary openings are provided shall bear costs thereof, and for restoring structure. Ample notice shall be given of size and location of such openings by Contractor requiring same.

- B. Holes provided in General Construction work to permit installation of lines for temporary mechanical services will, after removal of such lines, be patched as specified under Division 01.

1.26 TEMPORARY SERVICE

- A. Temporary services are specified under Division 01, "General Requirements".

1.27 CUTTING AND PATCHING

- A. The Contractor shall provide all floor and wall cuts as required for ductwork and piping penetrations of existing construction.
- B. No cutting of bearing walls, beams, etc., shall be done without the approval of the Architect. All patching and finishing, etc., shall match the surroundings. All cutting and patching shall be done by workmen skilled in the trades and in the employ of the General Contractor for the project. All cutting shall be done with saw type edges to give a neat and workmanlike appearance. All pipe holes shall be core drilled unless specified otherwise.
- C. Should it be necessary to do any cutting and patching due to the failure of this Contractor to give proper information to the General Contractor, it shall be done at the expense of the Mechanical Contractor.

1.28 PAINTING AND FINISHING

- A. Except as specified herein, the finished painting of Mechanical Work within the building and on the roof shall be as specified under Division 09.
- B. All mechanical equipment shall have a factory-applied prime and finish coat of paint. Galvanized surfaces shall be considered as finished surfaces for equipment rooms and items concealed from view. Plastic products shall be acceptable without a finish coat of paint. All items of equipment marred or rusted, even though factory finished, shall be repainted; steel angles and steel supports for ductwork, piping or miscellaneous equipment shall have a prime coat of paint before installation.
- C. General Contractor to paint all exposed piping, ductwork, equipment, and trim that does not have a factory applied finish. Refer to Division 09 "Painting" for paint materials, surface preparation and application of paint. Paint shall be semi-gloss, acrylic-enamel paint. Coat components with two (2) coats of finish paint over two (2) coats of rust inhibitive metal primer or approved equivalent based on component type.

1.29 CONCRETE WORK

- A. Concrete work shall be in accordance with Division 03.

1.30 SUSPENSION SUPPORT FOR DUCTS, PIPES, EQUIPMENT

- A. All pipes, ducts, and equipment that are suspended shall be connected directly to the building steel. Where hangers are required between building steel points, supplementary steel members shall be added by the Contractor as required to adequately support the load.
- B. Pipes and ducts shall not be supported from other pipes, ducts, or equipment.
- C. Hangers from joists shall be attached at the panel points. Pipes and ducts with weights of 50 pound per foot (total for single or multiple runs) routed parallel with bar joists shall be supported from a minimum of 3 joists at each hanger point (channel members between joists).

1.31 ACCESS PANELS – BUILDING

- A. Duct access panels, access plates, damper operators, fan cleanouts and valves located concealed in walls or above ceilings, and are otherwise inaccessible shall be furnished with an access panel for each location. A hinged inconspicuous type access panel complete with frame, of such size and so located as to provide proper access for service and maintenance.
- B. The minimum size of each access panel shall be 18" x 18" unless physical restraints require a smaller door.
- C. Where such equipment is located above removable concealed spline push up type acoustical tile or metal pan ceilings, it shall be considered as accessible if the acoustical material is arranged for access to the space above the ceilings.
- D. Access panels shall be Milcor "DW", or equal, for drywall locations and Milcor "K", or equal, elsewhere.
- E. Panels and frames shall be prime painted.
- F. Panels shall be furnished under this Division and installed under another Division of the Specification.
- G. Panel material shall be steel except that construction shall be all aluminum in bathroom applications.
- H. Access panels and doors in ductwork are specified in Division 23 – HVAC Ducts and Casings.
- I. When access panels or doors are installed in fire rated construction, they shall be fire rated to match the construction.

1.32 FIRESTOP PENETRATION PROTECTION SEALING SYSTEM

- A. Where pipes pass through fire partitions, firewalls, floors or ceilings, install a firestop that provides an effective barrier against the spread of fire, smoke, gases and water. Fire-stop material shall be packed tight, and completely fill clearances between pipe, sleeves and structure. All crack voids or holes (up to 4" diameter) shall be sealed using 3M brand Fire Barrier Caulk CP25 or putty 303 or an approved equal. Larger diameter or square holes, 3M

system 7902, 7904, 7902R or 7904R or approved equal shall be in accordance with manufacturer's instructions.

- B. Fire-stopping material shall maintain its integrity while preventing the passage of flame, smoke, gases or water. Fire-stopping material shall be a one-part, intumescent elastomer noncombustible, noncorrosive and compatible with synthetic cable jackets as defined by ASTM E814 (UL 1479); and in addition for insulation materials, melting points shall be a minimum of 1700 degrees F for one-hour protection and 1850 degrees F for 2-hour protection.

1.33 RECORD DRAWINGS

- A. The Contractor shall furnish record as-built drawings to the Architect at completion and acceptance of the job. Transparencies of the original drawings with corrections shall be submitted as specified in the General Requirements.
- B. Record all changes from installation originally indicated. Record final location of underground lines by depth from finished grade and by offset distances in feet and tenths to surface improvement such as buildings, curb, or edges of walks. Where work appears on two or more drawings, Contractor shall mark changes on all drawings. Contractor shall mark changes on all drawings. At completion, furnish the above required transparencies to the A/E for approval and record. Drawings shall be certified to be record of work installed and signed by the Contractor. Work shall not be accepted until such drawings have been delivered to the A/E.

1.34 GUARANTEE

- A. In addition to the requirements stated in the specifications, the Contractor must guarantee all equipment, materials, and appurtenances installed by him to be free from all defects for a period of one year from date of final acceptance.
- B. Upon written notice from the A/E, the Contractor shall promptly correct all defects without additional cost to the Owner. This Contractor shall adjust each part of the entire installation for proper working order. Reports are to be submitted to the A/E and adjustments repeated until the entire system is satisfactory. This Contractor must make good, at his own expense, any defects in materials or workmanship that may appear.

1.35 CLEAN UP

- A. The Contractor shall be held responsible for the general clean up of all areas affected by the work in the Contract. All rubbish and accumulative material shall be removed from the premises and the premises left "broom clean" upon completion.
- B. All stickers, rust, stains, labels and temporary covers shall be removed before final acceptance.
- C. Foreign matter shall be blown, vacuumed or flushed out of piping, pumps, fans, motors, devices, switches, panels, duct work and equipment.
- D. Identification plates on equipment shall be free of excess paint and shall be polished.

1.36 OPERATION AND MAINTENANCE MANUALS

- A. Submit to the Engineer for approval three manuals covering details of operation maintenance for all apparatus requiring service. The Contractor shall arrange formal instruction sessions by competent representatives of the manufacturer for the Owner's operating personnel to cover the following:
1. Service telephone number, fax number, websites, email addresses, business and service addresses and mobile telephone numbers of the installing contractor, and manufacturer and supplier and parts counters of all equipment.
 2. Manufacturer's operating and maintenance manuals, including detailed parts lists with numbers, power and control wiring diagrams for each piece of equipment and accessory requiring services or maintenance, the guarantee period and the name, address and phone number of the nearest sales and service organization for each item. Both on print and CD's (min 3 copies) form (PDF/MS Word).
 3. Cross out options that are not used on equipment sheets, highlight options selected.
 4. Step-by-step procedure for starting, stopping, setpoint adjustment, monitoring and alarm enunciation for each system.
 5. Copies of inspection certificates provided by the City, County, State and insurance companies.
 6. Provide separate Operation and Maintenance Manuals covering the FMCS and in compliance with this section.
 7. Routine maintenance procedures and scheduling for all mechanical equipment.
- B. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of the manuals.

1.37 INSTRUCTION TO OPERATIONAL PERSONNEL

- A. Furnish the services of competent instructors to give full instruction to the designated Facilities personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system on the Contract Documents. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
- B. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. Provide 4 man-hours of instruction for each: chemical treatment/glycol systems, pumps, exhaust and intake fans, heat exchangers, VAV boxes, 8 man-hours for the air handling units and components including the UV system, and 24 man hours instruction for the FMCS (operational, maintenance, programming instruction for trend logging and charting, setpoint adjustment schemes, alarm functionality and other routine operational commands/functions) required by the Owner's personnel..
- C. Instruction shall cover routine maintenance, control and power wiring diagrams and component analysis, preventative maintenance and scheduling, starting and stopping, alarm resets, trend-logging, setpoint adjustment, emergency and normal shutdown/startup, alarm date stamping and all else required by the Owner for complete usage/maintenance/adjustment of equipment in their intended systems.

- D. Obtain written statements from the Owner's representative acknowledging satisfactory completion of each item of instructions.

PART 2 - PRODUCTS

2.1 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Acceptable Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Accepted substitute in accordance with Section 01600.
 - 2. Sealing Elements: EPDM interlocking inks, shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.2 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.3 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With hinge and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.4 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, non-gaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000 psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PROJECT MANAGEMENT AND COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specification to ensure efficient and orderly installation of each part of the work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule
 2. Preparation of the Schedule of Values
 3. Installation and removal of temporary facilities and controls
 4. Delivery and processing of submittals
 5. Progress meetings
 6. Pre-installation conferences
 7. Project closeout activities
 8. Startup and adjustment of systems
 9. Project closeout activities
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into the work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

3.3 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

- a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequenced.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Number of Copies: Submit three opaque copies of each submittal. Architect, through Construction Manager, will return one copy.
 - a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect and Construction Manager will retain two copies; remainder will be returned. Markup and retain one returned copy as a Project Record Drawing.
 3. Refer to individual Sections for Coordination Drawing requirements for work in those Sections.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.
- 3.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL
- A. General: In addition to Project Superintendent, provide other administrative and supervisory personnel as required for proper performance of the work.
- 3.5 PROJECT MEETINGS
- A. General: Schedule and attend meetings and conferences at Project Site, unless otherwise indicated.
1. Agenda: Be prepared for the meeting agenda. Distribute the agenda to all invited attendees.
 2. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Attend a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later than 15 days

after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Procedures for processing field decisions and Change Orders
 - e. Procedures for requests for interpretations (RFIs)
 - f. Procedures for testing and inspecting
 - g. Procedures for processing Applications for Payment
 - h. Submittal procedures
 - i. LEED requirements
 - j. Preparation of Record Documents
 - k. Use of the premises and existing building
 - l. Work restrictions
 - m. Owner's occupancy requirements
 - n. Responsibility for temporary facilities and controls
 - o. Construction waste management and recycling
 - p. Parking availability
 - q. Office, work, and storage areas
 - r. Equipment deliveries and priorities
 - s. First aid
 - t. Security
 - u. Progress cleaning
 - v. Working hours
 2. Minutes: Record and distribute meeting minutes.
- C. Pre-installation Conferences: Attend a pre-installation conference at Project Site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents
 - b. Deliveries
 - c. Review of mockups
 - d. Possible conflicts
 - e. Time schedules
 - f. Manufacturer's written recommendations
 - g. Acceptability of substrates
 - h. Temporary facilities and controls
 - i. Coordination with other work

- j. Protection of construction and personnel
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Attend progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.
- 1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements
 - 2) Status of submittals
 - 3) Off-site fabrication
 - 4) Site utilization
 - 5) Hazards and risks
 - 6) Progress cleaning
 - 7) Status of correction of deficient items
 - 8) Requests for interpretations (RFIs)
 - 9) Status of proposal requests
 - 10) Pending changes
 - 11) Status of Change Orders
 - 12) Pending claims and disputes
 - 13) Documentation of information for payment requests
 - 3. Minutes: Record the meeting minutes.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

3.6 EQUIPMENT LOCATIONS

- A. Equipment locations: All mechanical equipment shall be located to provide for manufacturer's recommended clearances, clearance for routine maintenance, clearance per code requirements and locations/clearances required for removal/replacement in the future.
 1. Manufacturer's recommended clearances shall include space for proper airflow and non-short circuiting airflow pathway (condensing units, air cooled chillers, cooling towers, etc), clearance for pumps (18" minimum around pumps), 30" clearance or complete access door swings (air handling units), clearances for tube pulls (heat exchangers, chillers, coil pulls, etc); locate piping to be clear of these locations.
 2. Provide minimum 36" clearance around boilers, chillers, heat exchangers and other pressure vessels; note this is a minimum requirement, provide excess wherever possible. Provide minimum 42" clearance from power panels per the latest edition NEC having jurisdiction; include requirements for piping and ductwork at such locations.
 3. Locate equipment in mechanical rooms to allow for future removal and replacement. Include heights to overhead piping where applicable. Wherever possible, clearances shall include removal/replacement as a whole entity without knock-down.
 4. Access platforms with metal grating shall be provided for equipment located outdoors such for power and control panels for air cooled chillers, air handling equipment located on dunnage. This access system shall provide for maintenance and requirements per codes having jurisdiction. Platforms shall include stairs and handrails per OSHA regulations.
 5. Locate roof mounted equipment minimum 10' away from edges of roof. Where equipment is located closer, provide handrail system at roof edge as required per codes having jurisdiction. Maintain clearances from handrail system to power panels.
 6. Locate air intakes minimum 10' away from exhaust outlets and plumbing vents for all other applications.
 7. Locate air intakes for kitchen air intakes min 10' away from exhaust outlets from kitchen exhaust fans.

3.7 ACCEPTANCE TESTING

- A. An acceptance test of the HVAC system shall be performed by the Contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of the successful test, the Contractor shall so certify in writing to the Owner and General Contractor.
- B. The Contractor shall also utilize all sub-contractors such as sheetmetal, balancing, piping, controls and commissioning agent, and other contractors such as electrical, plumbing, fire alarm and communications as required to perform this acceptance test.

- C. The acceptance test shall be performed to determine that the protective measures required as outlined in NFPA 90A and shall function when needed in order to restrict the spread of fire and smoke.
- D. The acceptance test shall include testing the HVAC system to determine its full functionality and in compliance with NFPA 90A and the sequence of operation. All controls and equipment shall be modulated throughout their entire ranges and adjustments shall be made for optimum performance.
 - 1. Portions of control or alarm systems are permitted to have standby power or other emergency modes of operation.
 - 2. The tests shall be performed to determine that the system operates under the standby power or emergency operation mode as well as under normal conditions.
- E. All fire, smoke, combination fire/smoke dampers and ceiling dampers shall be operated and tested by the Contractor prior to occupancy of a building to determine that they function in accordance with NFPA 90A. A compliance report shall be forwarded to Engineer and Owner.

3.8 CONNECTION TO EXISTING UTILITIES

- A. If connecting to an existing piping system (water, gas, oil, sewer, steam, condensate, etc.). It shall be the responsibility of this contractor to verify the integrity of the existing piping system being connected. All applicable testing and acceptance will apply.
- B. If connecting to an existing duct system (supply, return, exhaust, etc.). It shall be the responsibility of this contractor to verify the integrity of the existing ducted system being connected. All applicable testing and acceptance will apply.
- C. Existing Pipe Testing: The contractor shall remove a section of piping at the point of connection between new and existing. The contractor shall determine the integrity of the existing piping after analysis of the piping section for tube wall thickness, scaling and corrosion. The analysis shall determine the ability for tie-in, pressure testing ability and remaining useful life. The contractor shall guarantee the piping integrity at the point of tie-in and subsequent acceptance. For existing piping not currently being used; the contractor shall pressure test in order to determine integrity and subsequent acceptance. Report all results in writing to the Architect/Engineer.
- D. Existing Ductwork Testing: The contractor shall examine the existing ductwork at the point of tie-in pertaining to gauge, reinforcement and joint methods in order to determine the successful tie in and operation of new systems. The contractor shall determine that the existing systems have adequate construction for new system pressure characteristics. The contractor shall guarantee the ductwork integrity at the point of tie in and subsequent acceptance. Report all results in writing to the Architect/Engineer.

3.9 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

- 1. New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern type.
 - b. Chrome Plated Piping: One piece, cast brass type with polished chrome plated finish.
 - c. Insulated Piping: One piece, stamped steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass type with polished chrome plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, stamped steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast brass type with polished chrome plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: Set screw.
 - h. Bare Piping in Unfinished Service Spaces: One piece, cast brass type with finish.
 - i. Bare Piping in Unfinished Service Spaces: One piece, stamped steel type with hinge.
 - j. Bare Piping in Equipment Rooms: One piece, cast brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped steel type.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One piece, floor plate type.
2. Existing Piping: Use the following:
- a. Chrome Plated Piping: Split casting, cast brass type with chrome plated finish.
 - b. Insulated Piping: Split plate, stamped steel type with hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast brass type with chrome plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel type with concealed hinge and spring clips.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass type with chrome plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: Split casting, cast brass type with finish.
 - h. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel type with hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: Split casting, cast brass type.
 - j. Bare Piping in Equipment Rooms: Split plate, stamped steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split casting, floor plate type.
- B. Sleeves are not required for core drilled holes, *except in mechanical and electrical rooms or other wet areas where sleeves shall extend 2 inches above finished floor and shall be made watertight.*
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical and electrical equipment areas or other wet areas 2 inches above finished floor level. Extended cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 3. Install sleeves that are large enough to provide ¼ inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 4. Steel Pipe Sleeves: For pipes smaller than 6 inches.
 - a. Steel Pipe Sleeves: For pipes 6 inches and larger, penetrating gypsum-board partitions.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast iron soil pipe to extend sleeve to 2 inches below finished floor level. Refer to Section 07620 – Sheet Metal Flashing and Trim for flashing.
 5. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Section 07920 – Joint Seals for materials and installation.
- E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeves size to allow for 1 inch annular clear space between pipe and sleeves for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast iron “wall pipes” for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- F. Underground, Exterior Wall Pipe Penetrations: Install cast iron “wall pipes” for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- G. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07840 – Firestopping Systems for materials.

- H. Verify final equipment locations for roughing-in.
- I. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

END OF SECTION 23 05 00

SECTION 23 05 10 - HVAC DEMOLITION

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 23 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of Division 23 systems.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
 - 1. Division 23 Sections for demolishing, cutting, patching, or relocating mechanical items.

1.4 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.5 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.6 SUBMITTALS

- A. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building managers and other tenants' on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- D. Predemolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before Work begins.
- E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.7 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project site to comply with requirements herein. Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Requirements of system downtime and scheduling with site personnel.

1.8 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
 1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. Owner assumes no responsibility for condition of areas to be selectively demolished.
 1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
 1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.
 - a. Processed concrete finishes.
 - b. Stonework and stone masonry.
 - c. Ornamental metal.
 - d. Matched-veneer woodwork.
 - e. Preformed metal panels.
 - f. Roofing.

- g. Firestopping.
- h. Window wall system.
- i. Stucco and ornamental plaster.
- j. Terrazzo.
- k. Finished wood flooring.
- l. Fluid-applied flooring
- m. Aggregate wall coating.
- n. Wall covering.
- o. Swimming pool finishes.
- p. HVAC enclosures, cabinets, or covers.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installations requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect/Engineer.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
 - 1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.
 - 2. Perform work during unoccupied night or weekend hours as required by Owner during disruption of utilities.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Building Owner or Representative will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- D. Utility Requirements: Refer to Division 23 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
 10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations begun.
 11. Provide demolition on an on-going basis, schedule permitting. Demolition of existing systems or portions thereof shall be performed without interruption of the operation of the central heating plant.
 12. Remove demolition debris on a continuous and daily basis as work proceeds. Do not leave debris in the room.

13. Schedule and locate dumpster space as required by the project and coordinate location with facility personnel.
 14. Remove from site boilers and other large pieces of equipment immediately upon movement. Coordinate schedule of removal trains and cranes with facility personnel so that removal minimizes impact on-site traffic movement.
- B. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without Architect's approval.
1. Non-shell Elements: 50 percent.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- F. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.
- G. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- H. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- I. Concrete Slabs-on-Grade: Saw cut perimeter of area to be demolished, then break up and remove.

- J. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
 - 1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
- K. Roofing: Remove no more existing roofing than can be covered in one day by new roofing. Refer to applicable Division 07 Section for new roofing requirements.
- L. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Division 01 Section "Construction Waste Management."
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 23 05 10

SECTION 23 05 29 - HANGERS & SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 WORK INCLUDED

- A. This Section includes hangers, supports, anchors, sleeves, seals, flashing and sealing for mechanical system piping and equipment.

1.3 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include:
 - 1. Division 05 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
 - 2. Division 21 Sections on fire-suppression piping for fire-suppression pipe hangers.
 - 3. Division 23 Section "Vibration Isolation for HVAC Components" for vibration isolation and seismic restraint devices.

1.4 REFERENCES

- A. ASTM A 36/A 36M-00a: Specification for Carbon Structural Steel
- B. ASTM A 780-00: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- C. ASTM C 533-95: Specification for Calcium Silicate Block and Pipe Thermal Insulation
- D. ASTM C 552-00 (Revised 2001): Specification for Cellular Glass Thermal Insulation
- E. ASTM C 1107-99: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- F. ASME B31.9-96: Building Services Piping
- G. 2001 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; Section IX, "Welding and Brazing Qualifications"

- H. AWS D1.1-00: Structural Welding Code – Steel
- I. MSS SP-58-93: Pipe Hangers and Supports – Materials, Design and Manufacture
- J. MSS SP-69-96: Pipe Hangers and Supports – Selection and Application
- K. MSS SP-89-98: Pipe Hangers and Supports – Fabrication and Installation Practices
- L. MSS SP-90-00: (Reaffirmed 1991): Guidelines on Terminology for Pipe Hangers and Supports
- M. MFMA-3-99: Metal Framing Standards Publication
- N. MFMA-102-99: Guidelines for the Use of Metal Framing
- O. SSPC-PA 1-2000: Paint Application Specification No. 1: Shop, Field and Maintenance Painting
- P. IAPMO PS 42-96: Pipe Alignment and Secondary Support Systems

1.5 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.6 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design seismic restraint hangers and supports for piping and equipment.

1.7 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.8 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers:
 - a. B-Line Systems, Inc.
 - b. Carpenter & Patterson, Inc.
 - c. Grinnell Corp.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. Unistrut Corp.
 - 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. Pipe Shields, Inc.
 - 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.
 - 5. Piping supports systems for Roofs:
 - a. Miro Industries, Inc.

- b. Curbs-Plus, Inc.
- c. PHP Systems/Design
- d. Reviewed Equivalent

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 - 2. Corrosion resistant for piping located outdoors such as including but not limited to steam piping.
 - 3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with non-insulated copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 - 2. Material for Hot Piping: ASTM C 552, Type I cellular glass for water and calcium silicate for steam and other high temperature pipes.
 - 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- D. Roof Support Systems:
 - 1. Provide an engineered piping support system by Miro or reviewed equivalent for all piping to be supported directly on the rubber roof. System shall be designed to spread the load of each support over a wide area to minimize point loading and provide a stable base as not to crush the polysio roof insulation. Pipe supports shall be provided with a means to protect the rubber roof from any punctures or abrasions that could result in leaks.
 - 2. All pipes shall be supported from adjustable height pipe rollers to allow longitudinal pipe movement from thermal expansion. Pipe roller system shall be designed to accommodate insulated piping. Pipe roller system shall be designed to accommodate insulated piping. Pipe support system to account for roof pitch and piping pitch for secure support of piping systems.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

2.4 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.5 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustable, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit hanger rods. Inserts not allowed on piping 2 inches and larger.

2.6 FLASHING

- A. Metal Flashing: 26 gauge galvanized steel.
- B. Lead Flashing: 5 lb./sq. ft. sheet lead for waterproofing; one lb./sq. ft. sheet lead for soundproofing.
- C. Flexible Flashing: Thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

2.7 SLEEVES

- A. Sleeves for Pipes: Schedule 10, black steel.
- B. Sleeves for Ductwork: 18 gauge, black steel.
- C. Fire Stopping Insulation: Glass fiber type, non-combustible.

- D. Caulk: Acrylic sealant.

2.8 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Provide copper plated hangers and supports for copper piping.

2.9 SEALS

- A. Mechanical Type; Interlocking synthetic rubber links; pressure plates and compression bolts. Include sleeve from same manufacturer.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. All Insulated Piping: Clamp shall not project through insulation.
 - b. All Insulated Piping: Use thermal-hanger shield and insert with clamp sized to match OD of insert. Pipe insulation and jacket shall be continuous, provide pipe accessories as required.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
 6. Insert Material: Length at least as long as protective shield.
 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- L. Supports shall secure pipes in place, shall prevent pipe vibration, maintain required grading by proper adjustment, provide for expansion and contraction and shall make a neat appearance. Supports shall be of strength and rigidity to suit loading, service and installed in a manner in which will not stress unduly the building construction. Hangers shall not be permitted from roof and floor slabs. Fasten hangers and supports to building framing wherever practicable. Where required, add supplementary steel members to support piping. Hangers shall be capable of vertical adjustment after piping is erected. Hanger rods shall not pierce ducts.
1. Support horizontal piping of steel as per following schedule:
 - a. NPS 3/4: Maximum span, 8 feet; minimum rod size, 1/4 inch
 - b. NPS 1: Maximum span, 8 feet; minimum rod size, 1/4 inch
 - c. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch
 - d. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch
 - e. NPS 2-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch
 - f. NPS 3: Maximum span, 8 feet; minimum rod size, 3/8 inch
 - g. NPS 4: Maximum span, 8 feet; minimum rod size, 1/2 inch
 - h. NPS 6: Maximum span, 8 feet; minimum rod size, 1/2 inch
 - i. NPS 8: Maximum span, 8 feet; minimum rod size, 5/8 inch
 - j. NPS 10: Maximum span, 8 feet; minimum rod size, 3/4 inch
 - k. NPS 12: Maximum span, 8 feet; minimum rod size, 7/8 inch
 - l. NPS 14: Maximum span, 8 feet; minimum rod size, 1 inch
 - m. NPS 16: Maximum span, 8 feet; minimum rod size, 1 inch
 - n. NPS 18: Maximum span, 8 feet; minimum rod size, 1-1/4 inches
 - o. NPS 20: Maximum span, 8 feet; minimum rod size, 1-1/4 inches
 2. Support horizontal copper tubing as per following schedule:
 - a. NPS 1/2: Maximum span, 6 feet; minimum rod size, 1/4 inch
 - b. NPS 3/4: Maximum span, 6 feet; minimum rod size, 1/4 inch
 - c. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch
 - d. NPS 1-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch
 - e. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch
 - f. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch
 - g. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch
- Rod diameter shall be the same as specified for steel pipe. Support plastic piping in accordance with manufacturer's published recommendations.
3. Vertical Piping Supports
 - a. Cast Iron and Steel: Support at each floor and intermediates by stays or bracing with a maximum spacing of 10 feet unless otherwise required by expansion conditions.

- b. Copper Tubing: Support at each floor intermediates by stays or bracing with a maximum spacing of 10 feet to prevent rattling and vibration, unless otherwise required by expansion conditions.
- c. Plastic and Glass: Support in accordance with published manufacturer's recommendations.
- d. Support vertical lines which rise from lowest story with base fitting set on concrete or brick pier, or by hangers located on horizontal connections to riser.
- e. Bolt pipe riser clamps securely to pipe; rest clamp and extension on building structure. In special cases where directed, weld clamp to pipe and to building steel. Where required, provide supplementary steel members for clamp rest.

3.3 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one-inch minimum into hub, 8 inches sheet clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk metal counter flash and seal.
- C. Seal floor, shower and mop sink drains watertight to adjacent materials.
- D. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flexible sheet flash and counter flash with sheet metal; seal watertight.

3.4 SLEEVES

- A. Provide sleeves at all pipe penetrations of floor and walls.
- B. Extend sleeves through floors one inch above finished floor level. Grout sleeves in place. Staff joint with fire stop insulation and caulk seal airtight.
- C. Duct penetrations of non-rated floors and walls shall have the edge joint stuffed with insulation and the caulk sealed, airtight. No sleeve is required.
- D. Duct penetrations of rated partitions and floor shall be sleeved with 12 gauge galvanized steel as per UL fire damper detail. Caulk all floor penetrations watertight between the floor and sleeve with fireproof caulk, airtight.
- E. Install chrome plated steel escutcheons at finished surface.
- F. Use mechanical seals at exterior wall pipe penetrations below grade.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.6 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.8 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Ceiling Plates: Where hanging rods or piping leave unsightly holes in ceilings in finished areas, provide plastic ceiling plates, Grinnell Figure 127 or cast iron ceiling plates with setscrew, Grinnell Figure 395.

END OF SECTION 23 05 29

SECTION 23 05 53 - IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 WORK INCLUDED

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Access panel and door markers.
 - 3. Pipe markers.
 - 4. Duct markers.
 - 5. Valve tags.
 - 6. Valve schedules.
 - 7. Warning tags.

1.3 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 REFERENCES

- A. ASTM C 1036-91 (Reapproved 1997): Specification for flat glass.
- B. ASTM D 709-92 (Reapproved 1997): Specification for laminated thermo-setting materials.
- C. ASME A13.1-96: Scheme for the identification of piping systems.

1.5 SUBMITTALS

- A. Submit product data.
- B. Submit list of wording, symbols, letter size and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function and valve manufacturer's name and model number. (also include maintenance manuals)

- D. Submit manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

- A. ASME Compliance: comply with ASME A13.1, "Scheme for the Identification of Piping Systems", for letter size, length of color field, colors and viewing angles of identification devices for piping.

1.7 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Color: Unless specified otherwise, conform the ANSI/ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Plastic Pipe Markers: As indicated herein.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number and serial number.
 - b. Capacity, operating and power characteristics and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.

- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions and speed.
 3. Size: 2-1/2 by 4 inches for control devices, dampers and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment. Markers for chemical fume or bio-hazard service shall be labeled accordingly.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe markers, General: Preprinted, color-coded, with lettering indicating service and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.4 DUCT IDENTIFICATION DEVICES

- A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return and exhaust). Include contact-type, permanent adhesive. Markers for chemical fume or bio-hazard service shall be labeled accordingly.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch-thick brass.
 2. Valve-Tag Fasteners: Brass S-hook.

2.6 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not

easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units.
 - b. Meters, gages, thermometers, and similar units.
 - c. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - d. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - e. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - f. Fans, blowers, primary balancing dampers, and mixing boxes.
 - g. Packaged HVAC central-station and zone-type units.
 - h. Tanks and pressure vessels.
 - i. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation: Pre-tensioned pipe markers. Use size to ensure a tight fit.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

- A. Install duct markers with permanent adhesive on air ducts in the following color codes:
 1. Green: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. Orange: For chemical fume or bio-hazard ducts.
 5. ASME A13.1 Colors and Designs: For hazardous material exhaust.
 6. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and convenience connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
 1. Valve-Tag Size and Shape:
 - a. Heating Water: 1-1/2 inches round.
 2. Valve-Tag Color:
 - a. Heating Water: Natural

3. Letter Color:

- a. Heating Water: Black.

3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCE FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. The work included under this section of the specifications consists of the furnishing of all labor, materials, equipment and service necessary to complete the inspections, testing, guarantee and acceptance of all HVAC work as shown on the drawings and specified herein.
- B. All work shall be tested to the satisfaction of the Architect/Engineer, for leaks, faulty joints, improper operation and inefficiency.
- C. Provide test pump, gauges, meters, other instruments, materials, and labor in connection with tests.
- D. Do not cover or paint any part of piping or connect equipment, before testing and obtaining approval.
- E. All equipment and piping shall be thoroughly cleaned of iron cutting and other refuse during assembly, installation and before testing.
- F. The work included under this section of specifications also consists of the furnishing of all labor, materials, equipment and service necessary to perform air and water balancing for the HVAC work on water circulating systems, on hot water heating, chilled water, air distribution and exhaust systems as shown on the drawings and as called for in these specifications.
- G. The balancing work shall include, but not be limited to the following items.
 - 1. The setting and adjusting of all dampers and accessories to achieve proper air distribution and patterns in all parts of the air supply and exhaust systems.
 - 2. The setting and adjusting of all belted fan speeds as may be required to attain proper total CFM deliveries.
 - 3. The inspection of the function and operation of all ATC air and hydronic controls to insure proper operation and control cycles.
 - 4. The setting and adjusting of all balancing cocks to attain the proper GPM deliveries in the various water piping systems.
 - 5. Verify the setting and flow through all factory set automatic balancing air and water devices.
 - 6. The setting and adjusting of all valves and pressure relief valves.
 - 7. The measurement of feed water and transfer pump flows.

8. The inspection of the function and operation of all deaerator controls to insure proper operation and control cycles.
9. The measurement of deaerator temperature.
10. Submitting a report on each phase of the work.

1.3 RELATED SECTIONS

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC
- C. Division 23 – Vibration Isolation
- D. Division 23 – Hydronic Specialties
- E. Division 23 – HVAC Commissioning
- F. Division 23 – HVAC Pumps
- G. Division 23 – Dehumidification Units
- H. Division 23 – Condensing Boilers
- I. Division 23 – Ductwork
- J. Division 23 – Ductwork Accessories
- K. Division 23 – Air Outlets and Inlets
- L. Division 23 – Sequence of Operation

1.4 REFERENCES

- A. AABC – Associated Air Balance Council – National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 – “Air Balancing”.
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 – “System Balancing”.
- D. NEBB – National Environmental Balancing Bureau – Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- E. TABB – Testing, Adjusting and Balancing Bureau.

1.5 SUBMITTALS

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit two (2) copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Certified Testing, Adjusting and Balancing Reports: Submit three (3) copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting and balancing Agent.

1.6 QUALITY ASSURANCE

- A. The Contractor shall procure the services of an independent air balancing and test agency who shall not have any affiliation with construction contractors, equipment sales or design engineering firms.
- B. The balancing agency shall specialize in the balancing and testing of heating, ventilating and air conditioning systems and shall provide proof of having successfully completed at least five projects of similar size and scope.
- C. The testing and balancing agency shall be approved and acceptable to the Architect/Engineer and shall not be replaced without the written approval and consent of the Architect/Engineer. All field work shall be under the direct supervision of a registered professional engineer who is a full time employee of the balancing agency.
- D. Submit biographic data on the balancing firm certification and certification of employees performing the work. Submit instrumentation types and proof of recent calibration. The instrumentation shall include electronic flow foods, meters that accept pressure measurement and/or with temperature compensation and other such modern industry accepted instrumentation.
- E. The testing and balancing agency shall be a certified member of the AABC, NEBB or TABB, unless otherwise approved.

1.7 PREPARATION FOR TESTING AND BALANCING

- A. The balancing agency shall report to and review the work required with the Design Engineer before beginning field balance work. The balancing agency shall make at least two inspection of the air system during construction and shall report its findings in writing to the Design Engineer. Prior to start of balancing systems; submit to the Engineer written procedures on balancing procedures.
- B. The balancing agency shall cooperate with the Design Engineer and the Contractor to effect smooth coordination of the balancing work with the job schedule. Final balancing shall be done at a time agreeable to the Architect.
- C. The balancing agency shall be responsible for getting the various systems into proper operation. They shall enlist the aid of the ATC subcontractor, equipment suppliers, and Contractor as may be required to effect proper operation consistent with the Contract Plans and Specifications.

- D. The Engineer shall have the option to spot check system balance and the balancing agency shall provide all equipment and labor as required.

1.8 JOB CONDITIONS

- A. Air balance and testing shall not begin until system has been completed and is in full working order with the specified filters in place. Place all systems and equipment into full operations and continue the operation during each working day of testing and balancing.
- B. Procedure and test shall be as specified. Procedure and test not specified shall be in accordance with Associated Air Balance Council publication, "National Standards for Field Measurements and Instrumentation, Total System Balance" and 2011 ASHRAE HVAC Applications Guide Chapter 57 "Testing Adjusting and Balancing."
- C. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.
- D. The Contractor shall make any replacements in fan drive, sheaves and belts, and furnish additional dampers, balancing valves, cocks and fittings required for correct balance as required to meet design data.
- E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by the instrument manufacturer.

1.9 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting and balancing activities.
- B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS

- 2.1 Not Applicable

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine project record documents described in Division 01 Section "Project Record Documents."
- D. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- F. Examine system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- L. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

- M. Examine open-piping system pumps to ensure absence of entrained air in the suction piping.
- N. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multi-zone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 - 5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to design values.
- O. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 GENERAL PROCEDURES

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- B. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.3 AIR DISTRIBUTION TEST AND BALANCE

- A. All filters shall be clean and in place before starting fans. All air filters shall be artificially loaded by partial blanking or other means to produce air pressure drop midway between clean and dirty as specified. Controls and dampers shall be set for normal full air flow testing and balancing.
- B. During testing and balancing period, all supply, return and exhaust air fans shall have speeds adjusted and drives changed where necessary so that fans deliver design CFM at the actual static pressure developed by the installed system. Increasing static pressure by dampering at fan or closing all volume dampers to induce system static will not be permitted. External static pressure noted in schedules on drawings included drops through duct systems, terminal units and diffusers. Total static pressures must be calculated by adding pressure drops through unit mounted coils and dirty filter conditions, and unit conversion losses if applicable to that of the previously mentioned components. Provide minimum one (1) fan sheave and drive change per fan system.

- C. Adjust all air ducts to proper design CFM. Air quantities shall be adjusted by volume or splitter dampers. Dampers and other balancing devices shall have their adjusted positions marked in an inconspicuous permanent manner.
- D. Test and adjust each heat pump, diffuser, grille, register and primary within plus or minus 10 percent of design CFM requirements, but total air for each system shall be not less than indicated. Volume adjusters may be used to balance air quantities at outlets and inlets providing final adjustments do not produce objectionable drafts or sound levels in excess of specified limits. Design positive and negative pressure in each area must be maintained.
- E. Diffusers, register, grilles, shall be adjusted to minimize drafts in all areas.
- F. Diffusers, registers, grilles, shall be identified on test report as to location and areas.
- G. Reading and test of diffusers, registers, shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
- H. Record design and test CFM, static pressure, motor voltage and amps (nameplate and test) for each fan.
- I. Record design and test static pressure, in order of physical arrangement, for each system component, i.e., louver, filter, cooling coil, fan heating coil, etc., and the most remote terminal unit.
- J. With controls functioning properly water flow rates, test and record air dry bulb for supply air, and air entering and leaving each coil for each heat pump. Where feasible, measure air dry bulb and wet bulb temperatures with the mechanically aspirated psychrometer.
- K. Air distribution test and balance report shall include:
 - 1. Schematic diagram of each system showing size and CFM (design and actual) for main ducts; all dampers and regulating devices; terminal units; and each inlet and outlet with design and actual CFM.
 - 2. Test data form for each fan, heat pump.
 - 3. Tabulation of design, preliminary and final CFM for each diffuser, register, mixing box or other terminal. Summary of CFM tabulations by systems and comparison with respective fan data.
- L. Automatically operated dampers shall operate as specified or indicated. Testing agency shall check all controls that regulate air flow and pressure for proper calibrations and list controls requiring adjustment.
- M. As determined by the Engineer, for 10 percent of total rooms, tests and record hourly for four hours, the following:
 - 1. Room design condition D.B. Heating and Cooling and W.B. cooling.
 - 2. Room actual condition D.B. Heating and Cooling and W.B. cooling.
- N. For variable-air volume systems, develop a plan to simulate diversity.

- O. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- P. Check the airflow patterns from the outside-air louvers and dampers and the return and exhaust air dampers, through the supply-fan discharge and mixing dampers.
- Q. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- R. Verify that motor starters are equipped with properly sized thermal protection.
- S. Check dampers for proper position to achieve desired airflow path.
- T. Check for airflow blockages.
- U. Check for proper sealing of air-handling unit components.
- V. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

3.4 WATER TEST AND BALANCE

- A. Preparation: Prepare water systems for balancing in the following manner:
 - 1. Open all valves to full open position.
 - 2. Assure that all strainers have been cleaned.
 - 3. Examine water in system. If dirty or untreated, drain system, and refill with clean treated water.
 - 4. Check pump rotation and correct if necessary.
 - 5. Check expansion tanks to determine that they are not air-bound or water-bound and that system is completely full of water.
 - 6. Check all air vents at high points on water systems and determine all are installed and operating freely.
 - 7. Set all temperature controls so coils are calling for full cooling. This should close all automatic bypass valves at coil and converters. Same procedure when balancing hot water coils, set on full call for heating.
 - 8. Check operation of automatic bypass valve.
 - 9. Complete air balance must have been accomplished before actual water balance begins.
 - 10. Automatically operated valves shall operate as specified or indicated. Testing agency shall check all controls that regulate hydronic flow and pressure for proper calibration and list controls requiring adjustment.
- B. Adjustment: Proceed as follows:
 - 1. Set pumps to proper gallons per minute delivery.
 - 2. Adjust water flow.
 - 3. Check leaving water temperatures and return water temperatures. Reset to correct design temperature.
 - 4. Check water temperature at inlet side of coils. Record rise or drop of temperatures from sources.

5. Proceed to balance each coil.

C. Readjustment: Proceed as follows:

1. After adjustment to coils are made, recheck settings at pump and readjust if required.
2. Install pressure gages on coil, read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
3. Check record and include in the test report the following items.
 - 1) After adjustments to coils are made, recheck settings at pump and readjust if required.
 - 2) Install pressure gages on coil, read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
 - 3) Check record and include in the test report the following items.
 - a) Inlet water and air temperatures (dry bulb and wet bulb) at each coil.
 - b) Leaving water and air temperatures (dry bulb and wet bulb) at each coil.
 - c) GPM and pressure drop at each coil, heat exchanger, boiler, chiller and other similar devices.
 - d) Pressure drop across each coil bypass where obtainable.
 - e) Operating suction and discharge pressures and final T.D.H. for each pump.
 - 4) List all mechanical specifications of pumps; pump head, gpm and horsepower.
 - 5) List rated and actual running amperage of pump motor.
 - 6) Check water metering device readings.

3.5 TEST AND BALANCE REPORTS

- A. All tests and balance reports and other requirements of this section will be completed and furnished to Engineer prior to Final Inspection. Submit four copies. Use format similar to forms of Sheet Metal & Air Conditioning Contractors Association, Inc., Washington, D.C., or Associated Air Balance Council, Los Angeles, California.
- B. Types, serial numbers, and date of calibration of all instruments shall be included.
- C. Reports shall identify conspicuously items not conforming to contractor requirements, or obvious maloperation and design deficiencies.

3.6 MARKING OF SETTINGS

- A. Following final acceptance of Certified Reports by the Architect, the setting of all valves, dampers and other adjustment devices shall be permanently marked by the Contractor, so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

- B. Marking of the set point shall be with an arrow indicator. Method shall be by stamping or cutting the balance post or lever. A water proof marker may be used for indication on non wear surfaces.
- C. Temporary marks shall be used during rough balance and before approval of the balance report for reference. Temporary marks shall be removed upon final marking.

3.7 PIPING SYSTEMS TESTS

- A. Pressure tests shall be performed on all piping before equipment is hooked up to the piping.
- B. Refer to Division 23 Piping Specifications for requirements.

3.8 SPECIAL TESTING

- A. Test and set relief valves to specified relief pressure. Test and adjust pressure reducing valves to specified reduced pressure. Test and adjust meters and other instruments, after installation, to assure accurate operation. Replace all gauges and thermometers that are out of calibration.

3.9 ADJUSTMENTS, REPAIRS AND RETESTS

- A. Adjust, repair and retest the systems as specified herein.
- B. Correct defects disclosed by tests or inspection; replace defective parts when directed. In replacing defective parts, use only new material; in the case of pipe replace with same length as defective piece. Caulking of screwed joints and peeling of welds will not be permitted. Repeat tests after defects have been corrected and part replaced, as directed until pronounced satisfactory.
- C. The cost of repairs and restoration of work of other trades damaged by tests, or cutting that had to done in connection with test, shall be made at no extra cost to the Owner.

3.10 OIL AND SERVICING

- A. All bearings and packing glands shall be properly protected during installation. Before the equipment is placed in operation, they shall be filled with the type of lubricant recommended by the manufacturer of the apparatus. Prior to final acceptance all equipment flanks shall be repacked and all valve packing glands tightened.
- B. At completion of the work, prior to is operation by the Owner, all overload devices in motor starters shall be replaced or adjusted as required for proper operation of the motors. All damage to materials, equipment or finish of any part of the work resulting from the final adjusting of the equipment all be repaired to match the new condition of work.
- C. All such repairs shall be the responsibility of the contractor who shall have mechanics of the trade who originally installed the work make the repairs.

3.11 PERFORMANCE TESTS AND ACCEPTANCE

- A. Before final acceptance of the HVAC system, the contractor shall test the HVAC systems under normal conditions for two 8-hour days or longer when so directed to determine that they fulfill requirements of plans, specifications and that they operate satisfactorily.
- B. Contractor shall cooperate with the temperature control manufacturer to integrate the control system with the HVAC system.
- C. Heating system operating test shall be made during the heating season of the first year of operation at time when directed, for proper setting and adjustment of control under peak load conditions.
- D. Air condition operating test shall be made during the summer months of the first year of operating at time when directed for proper setting and adjusting of controls under peak load conditions.
- E. Contractor shall subject ventilating systems to operating tests for a period of two hours minimum for each system to demonstrate that each complied with the requirements of plans and specifications, that controls are functioning properly, and equipment operates satisfactorily.
- F. Any defects made manifest by those tests shall be immediately and promptly made good after which the system shall be retested as required and/or directed.
- G. Under no conditions will final payment be considered until results of all tests and adjustments have been submitted to and approved by the Architect.

3.12 INSPECTION

- A. This contractor shall obtain all inspections required by laws, ordinances, rules and regulations of State, Local authority having jurisdiction, and he shall obtain certificates of such inspections and submit them to the Architect and shall pay all fees, charges, and other expenses in connection with the same, and include same in contract price.
- B. This contractor shall furnish and install such test fees and plug fittings in his work as may be required by local authorities for their test and any other test required and shall ascertain information from local authorities as to all requirements before installation of work. No claims for extension of time will be entertained which arise from failure to obtain this information in time, or securing the necessary permits and arranging for required inspection.

3.13 ACCEPTANCE TESTING

- A. An acceptance test of the HVAC system shall be performed by the Contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of the successful test, the Contractor shall so certify in writing to the Owner and General Contractor.
- B. The Contractor shall also utilize all sub-contractors such as sheetmetal, balancing, piping, controls and commissioning agent, and other contractors such as electrical, plumbing, fire alarm and communications as required to perform this acceptance test.

- C. The acceptance test shall be performed to determine that the protective measures required as outlined in NFPA 90A and shall function when needed in order to restrict the spread of fire and smoke.
- D. The acceptance test shall include testing the HVAC system to determine its full functionability and in compliance with NFPA 90A and the sequence of operation. All controls and equipment shall be modulated throughout their entire ranges and adjustments shall be made for optimum performance.
 - 1. Portions of control or alarm systems are permitted to have standby power or other emergency modes of operation.
 - 2. The tests shall be performed to determine that the system operates under the standby power or emergency operation mode as well as under normal conditions.
- E. All fire, smoke, combination fire/smoke dampers and ceiling dampers shall be operated and tested by Contractor prior to occupancy of a building to determine that they function in accordance with NFPA 90A, compliance report must be forwarded to Engineer and Owner.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Ductwork insulation.
- B. Insulation jackets.

1.2 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC

1.3 REFERENCES

- A. ANSI/ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation.
- B. ANSI/ASTM C534 – Flexible Elastomeric Cellular Thermal Insulation.
- C. ANSI/ASTM C612 – Mineral Fiber Blocks and Board Thermal Insulation.
- D. ASTM E84 – Surface Burning Characteristics of Building Materials.
- E. NFPA 255 – Surface Burning Characteristics of Building Materials.
- F. UL 723 – Surface Burning Characteristics of Building Materials.
- G. Energy Conservation Construction Code of New York State, latest edition.
- H. ASHRAE 90.1 latest edition.

1.4 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five (5) years minimum experience of projects of similar size and scope.
- B. Materials: UL listed; frame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84.

1.5 SUBMITTALS

- A. Submit product data under provisions of Division 23 – Basic Mechanical Requirements.

- B. Include product description, list of materials and thickness for each service, and locations.
- C. Submit sound transmission loss for 125 to 4000 Hz frequencies on Type E insulation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES – INSULATION

- A. Owens-Corning
- B. Johns Manville
- C. Certainteed
- D. Knauf
- E. Armacell
- F. Thermal Ceramics

2.2 MATERIALS

- A. Type A: Flexible glass fiber; ANSI/ASTM C553 and ASTM C 1290; commercial grade; "k" value of 0.29 at 75 degrees F; rated to 250 degrees F; 3/4 lb. density; foil scrim kraft facing for air conditioning ducts. Manville R Series Microlite (Basis of Design).
- B. Type B: Rigid glass fiber; ANSI/ASTM C612, Class 1; "k" value of 0.24 at 75 degrees F; 3 lb./cu. ft. density; rated to 350 degrees F; foil scrim facing for air conditioning ducts. Manville Spin-Glass Board (Basis of Design).
- C. Type C: Flexible elastomeric rubber; ASTM C534, 0.08 perm-in water vapor permeability; 0.28 "k" value of 0.25 at 75 degrees F; 25/50 flame/smoke developed rating per ASTM E84. Armacell AP/Armaflex as Basis of Design.
- D. Adhesives: Waterproof (fire-retardant) type.
- E. Finishing Cement: Fire resistive to ASTM E84.
- F. Joint Tape: Foil backed.
- G. Tie Wire: Annealed steel, 16 gage.
- H. Glass Cloth Jacket: MIL-C-20079H, plain weave, 8 oz/sq yd.
- I. Aluminum Jackets: ASTM B209; 0.020 inch thick; smooth finish.
- J. EPDM Jackets – 0.060" thick, adhered, Mule-Hyde.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after ductwork has been tested and approved.
- B. Clean surfaces for adhesives.

3.2 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attach insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- J. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- K. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

- L. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- M. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
 - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
- N. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly jointed to interior insulation ends.
 - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.+
- Q. Insulate diffuser plenums and housings with Type A or B, 2" thickness in a neat manner with vapor barrier jacket and continuous insulation from flex duct to diffuser at ceiling.

3.3 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Provide insulation with vapor barrier when air conveyed may be below 60 deg. F. All supply air ductwork throughout shall be insulated with the minimum 1 ½" insulation, type A, unless specifically scheduled. (See 3.5 Schedule)
- C. Continue insulation with vapor barrier through penetrations.
- D. Where intended lining is used, external insulation may be deleted unless indicated otherwise. Internal insulation shall be of sufficient thickness/R-Value to comply with the energy code where external insulation is deleted.
- E. Insulate outdoor ductwork externally even if insulated internally.
- F. Type A Application
 - 1. Secure insulation with vapor barrier on all ductwork and conveying components with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners when necessary to prevent sagging. Seal vapor barrier penetrations by mechanical

fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Type B Application

1. Secure insulation with mechanical fasteners on 15 inch centers. Butt all joints tight.
2. On insulation with vapor barrier, cover all mechanical fasteners and joints with foil back adhesive tape.
3. On non-vapor barrier ducts, use plain white facing on insulation.
4. On exterior applications, finish with .060" thick "Mule-Hyde", EPDM top jacket.
5. Duct work insulation that is exposed in occupied spaces, shall have an additional layer of Kraft paper jacket with vapor sealing tape and/or an 8 oz./sq. yd. canvas cloth wrap, glued with two coats of sizing. Finish by painting with two coats of latex based paint. Color to be selected by Architect.

H. Type C Application

1. Apply in sheets; adhered 100% coverage to ductwork after has been cleared as per manufacturer's recommendations to duct with all edges butted and joints. Overlap joints for installation of multiple layers.

3.4 SCHEDULE

DUCTWORK	TYPE	MINIMUM THICKNESS (Inch)*	MINIMUM INSTALLED R-VALUE
Supply & Return Air Duct (Mechanical Rooms)	B	2.0	R-8
Supply Air Duct (Exposed in Conditioned Space)	B	1.5	R-5
Supply & Return Air Duct (Unconditioned Concealed)	A	2.0	R-6
Outside Air Intake	C	2.0	R-7

*Listed thickness is the minimum thickness commonly available. Provide insulation with greater thickness, if required, to meet the installed R-Value. Insulation thickness less than listed must get approval for use from the engineer.

** Supply Air Ducts within Return Air Plenums or Supply Air Ducts not insulated/described within Schedule shall receive insulation as indicated herein: Type A, 1.5, R-5.

END OF SECTION 23 07 13

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Piping insulation.
- B. Jackets and accessories

1.2 RELATED WORK

- A. Division 23 – HVAC Scope of Work
- B. Division 23 – Common Work Results for HVAC

1.3 REFERENCES

- A. ANSI/ASTM C195 – Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM C533 – Calcium Silicate Block And Pipe Thermal Insulation
- C. ANSI/ASTM C547 – Mineral Fiber Preformed Pipe Insulation.
- D. ANSI/ASTM C552 – Cellular Glass Block and Pipe Thermal Insulation.
- E. ANSI/ASTM C534 – Flexible Elastomeric Cellular Thermal Insulation.
- F. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM C449 – Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- H. ASTM E84 – Surface Burning Characteristics of Building Materials.
- I. NFPA 255 – Surface Burning Characteristics of Building Materials.
- J. UL 723 – Surface Burning Characteristics of Building Materials.
- K. Energy Conservation Construction Code of New York State, latest edition.
- L. ASHRAE 90.1, latest edition.

1.4 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five (5) years minimum experience of projects of similar size and scope.
- B. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50 in accordance with ASTM E84.

1.5 SUBMITTALS

- A. Submit product data under provisions of Division 23 – Common Work Results for HVAC.
- B. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Owens-Corning
- B. Johns Manville
- C. Certainteed
- D. Armacell
- E. Pittsburgh Corning
- F. Knauf

2.2 INSULATION

- A. Type A: Glass fiber insulation; ANSI/ASTM C547; "k" value of 0.24 at 75 degrees F; noncombustible.
- B. Type B: Elastomeric rubber; ANSI/ASTM C534; rigid closed cell; maximum water vapor transmission rating of 0.01 perms; "k" value 0.25 at 75 degrees F. Armacell AP/Armaflex as Basis of Design.

2.3 JACKETS

- A. Interior Applications
 - 1. All Service Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
 - 2. PVC Jackets: One piece premolded type. PVC jackets not allowed in return air plenums unless ASTM E84 25/50 rated.

3. Glass Cloth Jacket: MIL-C-20079H, plain weave, 8 oz/sq yd.

B. Exterior Applications

1. Aluminum Jackets: ASTM B209; 0.020 inch thick; smooth finish.

2.4 ACCESSORIES

- A. Metal Jacket Bands: 3/8 inch wide; 0.15 inch thick aluminum.
- B. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation through all penetrations including roofs, floors and walls.
- C. In exposed piping, locate insulation and cover seams in least visible locations.
- D. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or the heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used.
- E. Neatly finish insulation at supports, protrusions and interruptions. Insulate overhead traced sections of pipe, provide heat transfer compound.
- F. Jackets
 1. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have all service jackets, factory-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjoining pipe, and finish with PVC jackets.
 2. Indoor, Cold Applications: Insulated pipes conveying fluids below ambient temperature shall have vapor barrier jackets, factory-applied. Insulate fittings, Joints, and valves with molded insulation of like material and thickness as adjacent pipe and finish with PVC jackets. Leave no metal surfaces exposed.
 3. Exterior Applications: Provide all service jackets with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints and valves with

insulation of like material and thickness as adjoining pipe, and finish with aluminum jackets. Cover small areas of exposed insulation with Manville Insulkote primer and finish coating.

4. Calcium Silicate: Glass cloth jacket on indoor insulation. Use aluminum jacket on outdoor insulation.
5. PVC Jackets: Factory preformed, 30 mil thickness, UV resistant, noncombustible and 25/50 rated as per ASTM E84, nonconductive. Manville Zeston 2000 PVC. Secure with solvent adhesive. Cover joints and fittings with preformed PVC covers.

3.3 SCHEDULE: TYPE AND JACKET

PIPING	TYPE	VAPOR BARRIER
Glycol Piping (Indoor)	A	YES
Heating Water Supply and Return	A	NO
Low/Medium/High Pressure Steam Piping	A	NO
Low/Medium/High Pressure Steam Condensate	A	NO
Chilled Water (Indoors)	A	YES
Cold Condensate Drains	A	YES
Refrigerant Suction	C	YES
Refrigerant Hot Gas	A	YES
Glycol Piping (Outdoors)	D	YES
Pumped Condensate Return	A	NO
Chilled Water Piping (Outdoors)	D	YES
Heating Water Piping (Outdoors)	D	YES
Steam (Outdoors)	D	YES
Glycol Piping (In Mechanical Rooms)	C	YES
Chilled Water Piping (In Mechanical Rooms)	C	YES
Generator Exhaust	B	NO
Radiant Heating and Cooling Tubing Above Slab	C	YES
Radiant Heating and Cooling Manifolds	C	YES

Note: Insulate all existing piping in addition to the new.

SCHEDULE: THICKNESS

MINIMUM PIPE INSULATION *****

INSULATION THICKNESS FOR PIPES SIZES

Piping System Types	Fluid Temperature Range	Pipe Size					
		Runouts* Less Than 1 in.	Less than 1 in.	1 - <1-1/2 in.	1-1/2 - < 4 in.	4 - <8 in.	8 in. & Larger

<u>Hot Temperature Piping</u> High Pressure Steam, Hot Water or other fluid	306-1200	3.0	4.5	5.0	5.0	5.0	5.0
Medium Pressure Steam, Hot Water or other fluid	251-305	2.0	3.0	4.0	4.5	4.5	4.5
Low Pressure Steam, Hot Water or other fluid	201-250	1.5	2.5	2.5	2.5	3.0	3.0
Hot Water or other fluid**	100-200	1.5	1.5	1.5	2.0	2.0	2.0
Steam Condensate	Any	1.5	1.5	1.5	2.0	2.0	2.0
<u>Low Temperature Piping</u> Cold Water and Drain Lines, Refrigerant, *** Chilled Water	40-55 <40	1.5 1.5	1.5 1.5	1.5 1.5	1.5 1.5	1.5 1.5	1.5 1.5

* Runouts to individual coils between control valve and coil (not exceeding 4 ft. in length).

** Include refrigerant hot gas.

*** Include refrigerant suction. Liquid line insulation is not required.

**** Increase insulation thickness for exterior piping by .5 inches minimum.

END OF SECTION 23 07 19

SECTION 23 08 00 - HVAC COMMISSIONING

PART 1 - GENERAL

- 1.1 GENERAL: Furnish labor and material to accomplish complete HVAC commissioning as specified herein. If this Contractor cannot meet the specification herein, the Contractor shall employ the services of an independent commissioning expert.
- 1.2 PURPOSE
- A. Verify operation and functional performance of HVAC systems for compliance with design intent, drawings and specifications.
 - B. Document HVAC test inspections.
 - C. Verify application of operation and maintenance manuals, as-built documents, spare parts listing, special tool listing, and other items that support the HVAC systems and equipment.
 - D. Coordinate and direct training to personnel for operation and maintenance of HVAC systems and equipment.
- 1.3 QUALITY ASSURANCE: Reference ASHRAE Guideline 1-1996, Guideline for Commissioning of HVAC Systems, and SMACNA HVAC System Commissioning Manual.
- 1.4 COMMISSIONING TEAM SHALL CONSIST OF:
- A. The contractor's representative
 - B. The controls sub-contractor's representative
 - C. The electrical sub-contractor's representative
 - D. The engineer's representative
 - E. The equipment vendors representative
 - F. The testing, adjusting and balancing Contractor's representative
 - G. The owner's representative
- 1.5 CONTRACTOR RESPONSIBILITY
- A. Plan, organize, and implement the commissioning process as specified herein.

- B. Prepare the commissioning plan and ensure its distribution for review and comment.
- C. Revise the commissioning plan as required during construction.
- D. Chair commissioning meetings and prepare and distribute minutes to all commissioning team members, whether or not they attend the meeting.
- E. Coordinate commissioning activities among all contractors, sub-trades, and suppliers.
- F. Carry out all required system readiness checks and documents the results as the checks are done.
- G. In cooperation with the controls sub-contractor, ensure all control point checkouts are carried out and the results documented as the checks are done.
- H. Observe or verify all start-ups and initial system operations tests and checks, which shall encompass all specified functional performance tests, ensuring the results are documents as the tests and checks are done.
- I. Ensure equipment and systems are operated for functional performance verification purposes.
- J. Ensure all required instruction and demonstrations are provided to the owner's designated operating staff.

1.6 COMMISSIONING PLAN

- A. Within one month after award of contract, the contractor shall review the design intent and intended commissioning procedure with the engineer. Within 3 months of award of contract, the contractor shall submit a detailed Commissioning Plan to the engineer for review. The Commissioning Plan shall contain the information necessary to document the commissioning process as it progresses from pre-start-up checks, to start-up, and initial operation and finally to functional performance verification of all systems. The Commissioning Plan must include detailed check lists, relevant to guiding and carrying out. ASHRAE Guideline 1 should be used as outline.

- B. Phase 1 – Systems Readiness and Start-up:

Before starting any equipment or systems, complete the system readiness or pre-start checks in the commissioning plan and document the results. The following conditions and items shall be completed as applicable.

- 1. Piping systems have been pressure tested as specified, found to be tight, with reports submitted.
- 2. Equipment has been lubricated.
- 3. Air system cleaning is complete, and particulate filters have been installed.
- 4. Vibration isolation and seismic restraints have been installed to specification and adjusted.
- 5. Equipment drives have been aligned.
- 6. Electrical services have been installed and checked.

7. Control point checkouts have been completed.
8. Safety controls have been installed and operation checked.
9. Major equipment start-up has been carried out by manufacturer's representative and required start-up reports completed, submitted and approved.

All checks shall be documented on the relevant checklists as they are carried out. Deficiencies or incomplete work shall be corrected, and the checks repeated until the installation is ready for operation, before proceeding to Phase 2 of the process.

C. Phase 2 – Initial Operation:

In Phase 2 of the commissioning process, the contractor completes the testing, balancing, and calibration of all components and systems. They also operate all systems through all specified modes of operation, and test system responses to specified abnormal or emergency conditions.

Work carried out during this phase of commissioning shall include the following:

1. Air systems balancing, including positioning of all balance valve.
2. Correction of problems revealed during balancing, including changes to fan speeds or blade pitch as necessary.
3. Setting up and calibrating all automatic temperature control devices, including adjustments to control valves and damper actuators.
4. Verify the balancing contractor, and controls contractor are working together, setting up air flows and controls calibrations for variable volume terminal units and air valves where applicable.
5. Checking operation of all fire dampers, as was done in Phase 1, all checks and tests shall be documented on the relevant checklists as they are carried out.

Deficiencies or incomplete work shall be corrected, and the checks or test repeated until correct installation and function has been confirmed and the installation is ready for engineer verification.

D. Phase 3 – Functional Performance Verification

All equipment and systems shall be operated through the entire specified sequence of operations, as directed by the engineer for witnessing and verifying acceptable operation.

During this phase of commissioning, the following checks and test may be required by the engineer and shall be allowed for:

1. Checking the location and accessibility of all access panels.
2. Operation of all controls systems devices, both sensors and actuators.
3. Demonstration of acceptable noise and vibration levels from any equipment, under its full range of operational conditions.
4. Operation of equipment and systems under every specified mode of operation and sequence of control.
5. Operation of equipment and systems under normal, abnormal, and emergency conditions.
6. Acceptance testing as indicated in 3.3 herein.

E. Phase 4 – Demonstration and Instruction:

The formal demonstration and instruction for operating staff shall commence once the Phase 3 commissioning is complete and substantial completion achieved.

Demonstration and instruction shall cover all equipment and systems, and their controls. Detailed requirements are listed in the following sections of the specification.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

Instrumentation will be provided by agency performing prior tests. Instruments will be operated by individual agency requested by the HVAC Commissioning Authority, as specified elsewhere herein.

PART 3 - EXECUTION

3.1 HVAC Commissioning shall begin after HVAC equipment and systems, along with related equipment, systems, structures and areas are complete.

3.2 The following systems shall be commissioned:

- A. Air-Handling Units – Installation checks; capacity tests for heating, cooling, air flow, and static pressures; operation of all controls.
- B. Controls and EMCS – Installation and operation of all devices; complete operation of all controls sequences in coordination with commissioning of all controlled systems.

3.3 ACCEPTANCE TESTING

- A. An acceptance test of the HVAC system shall be performed by the Contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of the successful test, the Contractor shall so certify in writing to the Owner and General Contractor.
- B. The Contractor shall also utilize all sub-contractors such as sheetmetal, balancing, piping, controls and commissioning agent, and other contractors such as electrical, plumbing, fire alarm and communications as required to perform this acceptance test.
- C. The acceptance test shall be performed to determine that the protective measures required as outlined in NFPA 90A and shall function when needed in order to restrict the spread of fire and smoke.
- D. The acceptance test shall include testing the HVAC system to determine its full functionality and in compliance with NFPA 90A and the sequence of operation. All controls and equipment

shall be modulated throughout their entire ranges and adjustments shall be made for optimum performance.

1. Portions of control or alarm systems are permitted to have standby power or other emergency modes of operation.
2. The tests shall be performed to determine that the system operates under the standby power or emergency operation mode as well as under normal conditions.

E. Provide two copies of the final Commissioning report to the Engineer and Owner.

END OF SECTION 23 08 00

SECTION 23 09 23 - DIRECT DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Control equipment.
- B. Software.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Division 23 – Hydronic Piping. Installation of control valves, flow switches, temperature sensor sockets, gage taps.
- B. Division 23 – Steam and Steam Condensate Piping. Installation of control valves, flow switches, temperature sensor sockets, gage taps.

1.3 RELATED WORK

- A. Division 23 – Common Work Results for HVAC
- B. Division 23 – Sequence of Operation for HVAC Controls

1.4 SUBMITTALS

- A. Submittals shall consist of: Data sheets of all products; wiring and piping interconnection diagrams, including panel and device power, and sources; list of all materials of all proposed devices and equipment; Software documentation: Sequence of Operations, in text form; Application Programs, Point Schedules; Control Schematics and System Diagrams.
- B. Submit shop drawings and product data under provisions of Division 01 and 23.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance manuals upon completion of the project.
- B. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.
- C. Include keyboard illustrations and step-by-step procedures indexed for each operation function.
- D. Dump of processor's programs on diskette and typed listing of program in control unit's programming language.

- E. Manufacturer's instructions and drawings for installation, maintenance and operation of all purchased items.
- F. Overall system maintenance instructions, including preventive maintenance and operation of all purchased items.
- G. Overall system shielding and ground scheme indicating all major components and ground paths.
- H. "As Builts" of all submittal data.

1.6 WARRANTY

- A. Provide one year warranty including parts and labor.

1.7 SYSTEM VENDOR

- A. The base bid controls system shall be an extension of the existing Niagara Framework based Building Management System as provided by C&S Operations, Inc.
 - 1. C&S Operation, Inc. contact:
Justin Lefkus
315-455-2000
jlefkus@cscos.com

1.8 SYSTEM SCOPE

- A. The HVAC contractor shall furnish and install a complete DDC automatic temperature control (ATC) system as described herein and/or on the drawing. Furnish all labor, materials, tools, equipment and services for fully functional control system as indicated, in accordance with provisions of the contract.
- B. Although such work is not specifically indicated, provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound secure and complete installation. Provide control wiring between field installed controls, indicating devices and unit control panels.

1.9 BACNET

- A. The system shall be compatible with ASHRAE Standard 135-1995-BACNET-a communication protocol for building automation and control networks.

PART 2 - PRODUCTS

2.1 DDC SENSORS

- A. All temperature devices shall use precision thermistors accurate to ± 0.36 °F over a range of -30 to 210 °F. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified. Averaging sensors shall be employed in all applications where the temperature might be subject to stratification. Immersion sensors shall be employed for measurement of temperature in chilled water, hot water, and glycol applications. Mount space sensors at 48" above finished floor.

2.2 CONTROL VALVES

- A. All automatic water control valves shall be 2-way or 3-way as indicated on the drawings, size on a 3 PSI pressure drop. All valves and damper motors on all air handling units shall be equipped with pilot positioners or sequencers to insure field adjustability of the operating range.
- B. All automatic steam control valves shall be modulating, 125 PSIG SWP at 250° F, have replaceable plugs and seats of stainless steel.
1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 3. Valves shall be equipped with pilot positioners or sequencers to insure field adjustability of the operating range.

2.3 MAGNETIC FLOWMETER SYSTEM

- A. The magnetic flowmeter system must comply with the following specifications:
1. Power supply: 120 V ac, 50-60 Hz or 10-30 V dc.
 2. Power consumptions: 30 watts maximum.
 3. Wiring: Standard Alpha or Belden (20 AWG for the signal cable, 14 AWG for the coil drive).
 4. Conductivity Limits: 5 micromhos/cm.
 5. Flow Rate Range: Capable of measuring fluids traveling between 0.04 and 30 feet per second in either forward or reverse flow.
 6. Total System Accuracy: 0.5% of rate from 1 to 30 feet per second (3 to 30 feet per second on wafer flowtubes) includes the combined effects of linearity, hysteresis, repeatability, and calibration uncertainty. An optional .25% calibration is available. Accuracy will be unaffected by changes in density, pressure temperature, or conductivity (above minimum limit).
 7. Low Flow Cutoff: 0.04 feet per second.
 8. Flowtube Compensation and Interchangeability: Initially calibrated in North America and recalibrate in North America at user's request.
 9. Calibration Technique: Calibrated at minimum of 3 flow rates to ensure accuracy across flow rate range of 1-30 feet per second.
 10. Quality System: Manufacturer must be compliant to ISO 9001.

11. Shipment: Flowtube covers to protect the flowtube lining during shipment.
12. Manufacturer shall be Rosemount, Inc. Series 8700 and transmitters or approved equal.

B. Magnetic Flowmeter Flowtube

The flowtube shall follow these functional, performance, and physical specifications:

1. All flowtubes shall be fully welded.
2. Flanged flowtube pipe material: 304SST
3. Wafer flowtubes as applicable.
4. Potted seal between tube and junction box to prevent process from migrating through conduit connections.
5. Flanged Flowtube Flange Material and Class: ASME B16.5 (ANSI) 150# carbon steel.
6. Liner Material: Polyurethane, Teflon, PFA.
7. Electrode Material: 316SST or Hastelloy C
8. Electrode Type: Standard or bulletnose type as a low-cost maintenance-free solution for coating applications. Bulletnose electrodes must protrude at least 0.2 inches into the flow stream.
9. Process Grounding:
 - a. Conductive Unlined Pipe: None required.
 - b. Non-conductive or Lined Pipe: 3rd grounding electrode or single grounding ring.
 - c. Coating Applications: Two grounding rings.
10. Conduit Connections: Two 3/4" – 14 NPT electrical connections
11. Submergence Protection: IP68, submerged underwater continuously at 30 feet.
12. Enclosure Rating: NEMA 4X.
13. Each flowtube must be hydrostatically tested to 1.5 times its rated pressure.

C. Magnetic Flowmeter Transmitter

The transmitter shall follow these functional, performance, and physical specifications:

1. Housing: Aluminum, 2 compartment.
2. Mounting Configuration: Remote wall-mount with 2-inch pipe mount brackets.
3. Output: HART communications, a digital flow signal, superimposed on a 4-20mA analog signal linear to flow rate.
4. Commissioning and Configuration: Four steps through either a local display or a handheld communication device. Upper and lower range values shall be adjustable without additional tools through local operator interface or HART-based communicator.
5. Local Configuration: Fifteen button keypad with descriptive text on the buttons to describe functionality relating to magmeter functionality.
6. Local Indication: Illuminated two line by 20-alphanumeric character to display flow rate, totalized flow rate, and error messages as determined by configuration.
7. Digital Signal Processing: User-selectable coil drive frequencies; user-adjustable noise reduction techniques including modifying number of samples and maximum percent limit.
8. Conduit Connections: Three 3/4" – 14 NPT electrical connections at the base of the transmitter to limit condensation entering the transmitter.
9. 6 wiring point connections are required for operation.

10. Ambient temperature compensating to ensure accuracy in changing environments.
11. Submergence Protection: IP 65.
12. Enclosure Rating: NEMA 4X.

2.4 FACILITY MANAGEMENT SYSTEM (FMS)

- A. The Facility Management System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.
- B. The facility management system shall consist of the following:
 1. Standalone DDC panels.
 2. Standalone application specific controllers (ASCs).
 3. Personal Computer Operator Workstations.
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels and operator devices.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

2.5 NETWORKING/COMMUNICATIONS

- A. Local Area Network
 1. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
 2. Dynamic Data Access: All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

2.6 STANDALONE DDC PANELS

- A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.
- B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and database including:
- C. Point Types: Each DDC panel shall support the following types of point inputs and outputs:
 - 1. Digital Inputs for status/alarm contacts
 - 2. Digital Outputs for on/off equipment controls
 - 3. Analog Inputs for temperature, pressure, humidity, flow and position measurements
 - 4. Analog Outputs for valve and damper position control and capacity control of primary equipment.
 - 5. Pulse Inputs for pulsed contact monitoring.
- D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.
- E. Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.
- F. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.
- G. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- H. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment.

The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

- I. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

- J. Power Fail Restart: In the event of the loss of normal power there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, a local port, or remote access. The user must have all software necessary to program and make adjustments to the equipment without engaging with a contractor.

- K. Provide at least 2 analog input, 2 analog output, 2 digital input, and 2 digital output points per panel area for future use.

2.7 SYSTEM SOFTWARE FEATURES

A. General

1. All necessary software to form a complete operating system as described in this specification shall be provided.
2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description

1. Pre Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
 - a. Two Position Control
 - b. Proportional Control
 - c. Proportional plus Integral Control
 - d. Proportional, Integral, plus Derivate Control
 - e. Automatic Control Loop Tuning
2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
4. Power Fail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

- C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling

2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Load Rolling
11. Fan Speed/CFM Control
12. Heating/Cooling Interlock
13. Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

- D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- E. Alarm Management: Alarm management shall be provided to monitor, buffer and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.
- F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data.
- G. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points.
- H. Analog/Pulse Totalization: Standalone DDC panels shall automatically single, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
- I. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

2.8 APPLICATION SPECIFIC CONTROLLERS – HVAC APPLICATIONS

- A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).
- B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
- C. Each ASC shall have sufficient memory to support its own operating system and data base including:
 - 1. Control Processes
 - 2. Energy Management Applications
 - 3. Operator I/O (Portable Service Terminal)
- D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.
- E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include but not be limited to the following:
 - 1. Display temperatures
 - 2. Display status
 - 3. Display setpoints
 - 4. Display control parameters
 - 5. Override binary output control
 - 6. Override analog setpoints
 - 7. Modification of gain and offset constants
- F. Power Fail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
- G. The following application specific controllers shall be available:
 - 1. VAV Terminal Controller
 - 2. Unitary Controller
 - 3. Air Handler Controller
 - 4. Lighting Controller

2.9 OPERATOR INTERFACE

- A. Basic Interface Description
 - 1. Command Entry/Menu Selection Process: Operator Workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.

The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

2. Graphical and Text-Based Displays: At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system pint and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.
 3. Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the FMS contractor shall provide at least two operator stations.
 4. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password. All access shall be logged as to person, time and level.
 5. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
 - a. Start-up or shutdown selected equipment
 - b. Adjust setpoints
 - c. Add/Modify/Delete time programming
 - d. Enable/Disable process execution
 - e. Lock/Unlock alarm reporting for each point
 - f. Enable/Disable Totalization for each point
 - g. Enable/Disable Trending for each point
 - h. Override PID Loop setpoints
 - i. Enter temporary override schedules
 - j. Define Holiday Schedules
 - k. Change time/date
 - l. Enter/Modify analog alarm limits
 - m. Enter/Modify analog warning limits
 - n. View limits
 - o. Enable/Disable Demand Limiting for each meter
 - p. Enable/Disable Duty Cycle for each load
 6. Logs and Summaries: Reports shall be generated automatically or manually, and directed to either displays, printers, or disk files.
- B. Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and hot water boiler systems, shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.
1. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 3. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 4. Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
- C. Personal Computer Operation Workstation Description: Personal computer operator workstations shall be provided for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the Standalone DDC panels to facilitate greater fault tolerance and reliability.
1. Workstation shall be general purpose, commercially available, personal computers with sufficient memory and processor capacity to perform all functions described in this specification.
 2. Sufficient bulk storage shall be provided to accommodate all fully configured point data bases, all application databases, all graphics data bases, all user-defined reports, and all historical data archival as described in this specification.
- D. Standalone DDC Panel
1. A multi-function touchpad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the DDC panel Operator Terminal shall change and limit touchpad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touchpad functions.

2.10 HVAC APPLICATION SPECIFIC CONTROLLER CONFIGURATION

- A. The Application Specific Controllers shall be configured using an intuitive, easy-to-use configuration tool. Standard, pre-tested HVAC applications will be "built-in" the tool. It is the intent that a non-programmer, fluent with HVAC systems and not necessarily with computer programming, be capable of using the configuration tool with minimal training.

PART 3 - INSTALLATION

3.1 GENERAL

- A. All wiring and tubing shall be properly supported and run in neat and workmanlike manner.

1. All wiring and tubing exposed in equipment rooms shall be run parallel to, or at right angles to the building structure.
 2. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.
- B. The control contractor shall be responsible for all electrical installation which is necessary to a fully functional system which is not shown on the electrical plans, or required by the electrical specifications. All wiring shall also be in accordance with applicable local and national codes.
1. All wiring shall be installed in conduit and be in accordance with the electrical specifications, Division 26.
 2. Electrical power for ATC panels shall be provided via dedicated circuits at the emergency power panel by the Division 26 Contractor.
- C. Pneumatic Piping
1. Air piping: Hard copper tubing, tube L with soldered joints or, where allowed by code, in accessible locations, polyethylene tubing with brass or rigid, unplasticized polyvinyl chloride fittings.
 - a. Provide copper tubing or polyethylene tubing in conduit for air piping in equipment rooms and air handling units except inside control panels.
 - b. Size in accordance with manufacturer's recommendations.
 2. Polyethylene tubing: Virgin black polyethylene
 - a. Molecular weight: Not less than 25,000.
 - b. Melt index: Not more than 0.3 decigram per minute.
 - c. Tube strength: To withstand 48 hour immersion in 100 percent IGEPAL solution at 73° F (22° C) in accord with ASTM-D1693.
 - d. Tube bundle configuration: In lie of racking groups of tubes.
 3. Adequately strap and support copper air piping, however, do not attach to ductwork, conduit or other systems. Do not use wire to support tubing.
 4. In equipment rooms and non-accessible locations, install polyethylene tubing in conduit. Use standard electrical boxes at junction points with covers so no portion of plastic tubing is exposed to physical damage.
- D. Control Wiring
1. Include low voltage wiring (100 volts and less) required for temperature control systems under this section.
 2. Conductors for control signals: No. 18 or 19 AWG copper conductors as required.
 - a. Connector may be assembled in cable with PVC insulation minimum of 0.016 in. thick.
 - b. Cable outer sheathing standard with manufacturer.
 - c. Line voltage wire for temperature control suitable for 600 volts, 168° F temperature with Type THW plastic covering, minimum of No. 18 AWG.
 3. Conduit

- a. Conduit: Electrical metallic tubing
- b. Couplings: Set screw
- c. Flexible conduit: Steel armor
- d. Provide conduit for all control wiring

E. Equipment

1. Temperature Sensing Wells

- a. Provide list with shop drawing of well locations to mechanical contractor.

2. In general; locate temperature sensors, humidity sensors, thermostats and humidistat for room control immediately inside of door, above light switch, or where shown.

- a. Where light switch is in an entryway to room, locate sensor and/or "stat" on wall within room so it is capable of sensing true space conditions.
- b. Prior to installation, coordinate sensor and/or thermostat locations with Contracting Officer.
- c. Where sensors are located on exterior walls they shall be protected from false readings. Mount the sensors on top of 3/4 inch thick wire mold back boxes. The back boxes shall be white in color and shall be insulated with 3/4" thick rigid insulation with foil facing on the outboard side. The sensor wire shall run thru the center of this insulation. The back box insulation and wire shall be sealed with silicone caulk and allowed to dry before the sensor is installed. The completed installation should be free from drafts from inside of the exterior wall.
- d. All wall sensors shall be mounted over recessed wall electrical device boxes.

3. Mount local control panels at convenient locations adjacent to equipment served.

- a. Mount all relays, PE switches, pressure switches, etc., internal to temperature control panels.
- b. Tag each instrument corresponding to symbols used on control diagrams.
- c. Make fully compensated capillaries connected to instruments of a length to allow them to be run in neat and workmanlike manner and placed in such position so that they will not obstruct service on equipment controlled.

4. Mounting of field microprocessors on air handling units shall not be allowed unless they are installed in a control enclosure.

3.2 COMMISSIONING

- A. Control system to be set up and checked out by factory trained, competent technicians skilled in the setting and adjustment of digital control equipment used in this project. This technician to be experienced in the type of systems associated with the control system.
- B. At time of final observation, demonstrate the sequence of operation for each system to architect. Perform system demonstration as directed by Owner and Architect.

3.3 TRAINING

- A. Provide a minimum of eight (8) hours of instruction to Owner's personnel in the operation and maintenance of the control systems. Provide training after the system has been installed and checked out.

3.4 WARRANTY

- A. At completion of final test of installation and acceptance by Owner, provide any service incidental to proper performance for a period of one year.
- B. Equipment shall be warranted for one year (including defects in workmanship and material under normal use and service). During warranty period supplier shall also replace or repair, free of charge, any equipment proven to be defective in workmanship or material.

3.8 CONTROL SEQUENCE

A. General Operation

- 1. Scheduling:
 - a. All HVAC equipment shall operate in occupied/unoccupied modes as determined by a schedule provided by the Owner.
- 2. Mode of operation (occupied/unoccupied) including building warm-up and pull-down cycles, as well as all system functions shall be programmable and controlled by the DDC system.
- 3. All systems shall maintain the scheduled or otherwise noted minimum outside air ventilation rate during occupied hours.
- 4. Provide normally open hot water control valves.
- 5. Provide normally closed chilled water control valves.
- 6. Provide normally closed outside air dampers and operators.
- 7. All setpoints shall be adjustable.

B. Rooftop Units RTU-1 & 2

- 1. Fan Operation:
 - a. The supply fans and the powered relief fan shall be started and stopped automatically by the DDC system according to building schedule anytime the operator has scheduled the selection of the unit to be enabled in system graphic. When enabled, the fans shall start and stop automatically according to building schedule.
 - 1) Start up: The supply fans shall ramp up over a five (5) minute period to a maximum duct static pressure of 1.5 in. w.c. in order to satisfy air terminal damper position setpoint. The DDC system shall monitor the damper position of all VAV terminals and adjust fan speed so that no more than (1) VAV terminal dampers are more than eighty-five (85) percent open and all room setpoints are met. The floating static setpoint shall have a high limit of 1.5 in. w.c. (adj.) at the duct mounted

- static pressure sensors. The supply fans shall vary speed accordingly to maintain damper positions and high static limit.
- 2) Normal occupied building operation: After Start up sequence has completed, the system shall transition into normal operating mode. The supply fan shall continue to operate to maintain one (1) VAV terminal at eighty-five (85) percent open with a maximum duct static sensor high limit of 1.5 in. w.c.. The powered relief air fan ASD shall modulate to maintain (1) VAVR damper position of 85% and respective return air flow setpoints for each of the associated VAVR terminals.
 - 3) Economizer operation: the supply and powered relief fans shall follow the same sequence as for normal operation.
2. Damper Control: The air handling unit contains one (1) outside air damper, one (1) return air damper and one (1) relief air damper. The outside air damper shall be controlled opposite to the return air damper, the relief air damper is barometric. Both outside air and relief air dampers shall be closed anytime the supply and powered relief air fans are off.
- a. Start-up: The outside air damper shall remain closed with the return air damper full open.
 - b. Normal occupied building operation: The outside air damper shall modulate to minimum position as determined during testing and balancing and the return air damper shall modulate opposite.
 - c. Economizer operation - free cooling: whenever the outside air temperature is a minimum of five (5) deg F lower than the return air temperature and the outside air temperature is between 50 degf (adj.) and 65 deg F (adj.). The unit shall be in the economizer mode of operation.
 - 1) The hot water coil control valve shall be fully closed and the mechanical cooling shall be disabled (if applicable).
 - 2) The outside air damper and return air damper shall modulate in sequence to maintain a mixed air temperature setpoint of 55 deg F (adj.).
3. Filter Status: Differential static pressure across the filters shall be monitored and an alarm shall be recorded at the DDC operator's workstation when the differential pressure exceeds 1.0 in. w.c. (adj.).
4. Hot Water Heating Coil: anytime the air handling unit fan is instructed to run and the hot water coil discharge air temperature is below setpoint, the heating coil control valve shall modulate to maintain the discharge air temperature setpoint. Anytime the outside air temperature is at or above setpoint or the supply fan is off, the coil temperature control valve shall be fully closed.
- a. During unoccupied periods and when the outside air temperature is thirty-eight (38) deg F or below the heating temperature control valve shall be open 5% (adj.).

5. DX Cooling Coil: when the air handling unit is not in economizer mode and when the associated spaces exceed their cooling setpoints the compressor signal shall be modulated to meet the discharge air temperature setpoint of 55 deg F (adj.).
6. Unit safeties sequence of operation: there are several safeties that can shutdown and interlock the unit off until it is once again safe to operate. They are as follows: low limit temperature (freeze-stat), high temperature limit, fire alarm shutdown, smoke detection, and general DDC safety shutdown. For all of the above mentioned safeties, on a failure, the unit fan ASD will not be allowed to operate either in automatic (remote) or hand (local) operation, until the safety has been resolved. Any time the supply is off via manual instruction, freeze stat (low limit) operation, static pressure limit or by manually/automatically disconnecting the electrical service to the unit (such as turning off or failure of the adjustable speed drive) the DDC system shall indicate an alarm on the air handling unit graphic.
 - a. Low limit protection (freeze stat): the unit should have a capillary type, auto reset freeze stat located on the inlet side of the DX cooling coil. Freeze stat shall trip below 37 deg F (manually adjustable between 35 deg F and 42 deg F) of measured coil inlet air temperature. On a freeze trip, the n.c. contacts to the supply fan (starter or ASD) shall open in order to disable the fan.
 - b. The N.O. contacts shall close for alarming to the DDC system and initiate the DDC failure mode of operation that includes commanding the equipment to its respective failsafe positions: outside air damper closed, supply fan disabled, the heating coil pump enabled and the temperature control valve shall set to full heating position by opening the hot water control valve. The N.C. contacts are wired to the control panel and power two (2) relays within the enclosure. When in the freeze condition the first relay shall be de-energized to kill power to all damper actuators allowing them to spring return to their respective failure positions. In the freeze condition the OA damper shall be closed (no outside air). The second relay shall de-energize and open the contacts at the supply fan starter or ASD to prevent it from running in "hand or auto mode". When the freeze stat is in alarm, a red alarm light shall be activated on the face of the control panel. These relays are to ensure that the unit shuts down safely in the event of a freeze stat trip regardless of what the controller is trying to do.
 - c. Fire alarm shutdown: the control panel shall monitor a single set of fire alarm contacts, shutdown and indicate this condition on the face of the panel. The physical shutdown shall be performed by an isolation relay to the supply fan ASD and not through the DDC controls. An alarm signal will be sent to the DDC system to notify operator that fire alarm signal has shut system down.
 - d. Duct mounted smoke detector: when smoke is detected the detector will send a signal to the fire alarm control panel. See above for unit shutdown protocol.

C. Variable Volume Air Terminal Units

1. Hot Water Reheat Only:
 - a. The individual variable volume zone shall be controlled through the DDC network with the following sequences.
 - b. The individual room sensors shall provide, to the stand-alone direct digital controller on the VAV box, the room temperature.
 - c. The DDC controller shall provide in a pressure independent fashion, the appropriate airflow to provide for cooling and heating.
 - d. Upon a call for cooling, the VAV box shall increase the airflow from its minimum setting and modulate up to the maximum box setting until space-cooling temperature is satisfied. The reheat coil valve to remain closed.
 - e. If cooling is not required, the VAV box shall maintain the minimum box setting. If the space sensor calls for heating, the VAV box shall maintain its minimum cfm setting and it shall modulate the normally open heating temperature control valve to maintain heating space temperature. If valve is at full open position for 5 minutes and space temperature setpoint is not met, then the VAV box shall increase its airflow above minimum setting until space temperature is satisfied. Once setpoint is reached, box shall return to minimum airflow setting and return to normal valve modulation sequence.
 - f. See Exhaust Fan Control Sequences for additional VAV sequences.
2. Hot Water Reheat and Radiation/Supplemental Heat:
 - a. The operation of the VAV/RH terminals are the same as in supply air terminal unit control with hot water reheat, with the addition of the fin radiation control valve. The valve shall modulate in parallel with the reheat coil control valves to maintain room setpoint temperature.
 - b. During building unoccupied times when room is in night setback and VAV airflow is off, the fin radiation control valve and reheat control valve shall continue to modulate to maintain room setpoint temperature.
3. Return Air VAVs (VAVR):
 - a. The DDC controller shall provide in a pressure independent fashion, the appropriate airflow based on current system mode.
 - b. See Exhaust Fan Control Sequences for additional VAVR sequences.

D. Fin Radiation and Convectors

1. Control valve shall modulate to maintain space temperature as sensed by wall (room) sensor.
2. Occupied/unoccupied scheduling shall be accomplished through the DDC system.

E. Exhaust Fan Control

1. EF-1AG, EF-4P, EF-5P, and EF-11P:
 - a. Each fan will run 24/7 and will not be managed by a occupied/unoccupied schedule.
 - b. The exhaust air damper is barometric and normally closed. The exhaust damper opens when the exhaust fan starts.
 2. EF-2AG, EF-3AG, VAVR-Ag, VAVR-Kitchen Classroom, Transfer Damper Kitchen Classroom:
 - a. When a single manual wall switch is activated in the agriculture area for welding or plasma cutting, the Kitchen Classroom Transfer Damper and the isolation dampers associated with the Exhaust Fans will be commanded open.
 - b. When the dampers indicate open, the fans will enable.
 - c. The DDC system will change the VAVR-Kitchen Classroom flow setpoint from 2,250 CFM to 650 CFM and VAVR-Ag flow setpoint from 6,500 CFM to 0 CFM.
 - d. When the manual wall switch is deactivated, the fans shall be commanded off. Once the fans are confirmed inactive, the Kitchen Classroom Transfer Damper and isolation dampers shall close, and the VAVR-Kitchen Classroom and VAVR-Ag setpoints shall return to standard operation values.
 3. EF-1LC, EF-2LC, EF-3LC, VAV-Printer, VAVR-Printer, VAV-Drone, VAVR-Drone, VAV-Laser, and VAVR-Laser
 - a. Each exhaust fan has its own associated manual wall switch used to enable the respective fan.
 - b. The exhaust fans are constant speed and the manual switches are on/off. The VAV boxes and OA dampers serving the associated room shall open to a CFM to match the exhaust fans that are turned on (using the airflow measuring stations in the VAV or RTU). When EF(s) is(are) turned on, RTU OA damper and associated VAV box shall open to provide additional make-up air CFM = the exhaust fan(s) CFM. As exhaust fans are turned off, the reverse shall occur.
- F. Use the factory controllers on the DHU-1/CU-DHU-1, ERU-1 and ERU-2. BAS shall provide alarms and monitoring of these units through factory provided BACnet connections.
1. Occupied Mode:
 - a. The fan shall run continuously and its associated damper shall open.
 2. Unoccupied Mode:
 - a. The fan shall be off.

END OF SECTION 23 09 23

SECTION 23 21 14 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Air vents
- B. Dirt/Air separators
- C. Strainers
- D. Pump specialties
- E. Pump triple duty valve
- F. Relief valves
- G. Pressure gauges
- H. Thermometers

1.2 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC
- C. Division 23 – Hydronic Piping
- D. Division 26 – Electrical Wiring Systems

1.3 REFERENCES

- A. ANSI/ASME – Boilers and Pressure Vessels Code
- B. ASME B31.9 – Building Services Piping

1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks and air separators.
- B. Conform to ASME 31.9 for materials, products and installation.

1.5 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 23 – Common Work Results for HVAC.
- B. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Submit shop drawings on the following:
 - 1. Dirt/Air separators
 - 2. Strainers
 - 3. Pump specialties
 - 4. Triple duty valves
 - 5. Relief valves
 - 6. Pressure gauges
 - 7. Thermometers
 - 8. Pressure independent control valves

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 23 – Common Work Results for HVAC. Submit ASME certification.
- B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – AIR VENTS

- A. Armstrong
- B. Bell and Gossett
- C. Wheatley
- D. Reviewed equivalent

2.2 AIR VENTS

- A. Manual Type: Line sized tee with ball valve and U-shaped copper pipe for discharge into hand-held container.
- B. Float Type: Cast iron body, stainless steel float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve. Bell and Gossett Model 107A Basis of Design, Metraflex MetraVent MV or reviewed equivalent.

2.3 ACCEPTABLE MANUFACTURERS – DIRT/AIR SEPARATORS

- A. Caleffi (Basis of Design)
- B. Spirotherm
- C. Taco
- D. Wessels
- E. Armstrong
- F. Reviewed equivalent

2.4 DIRT/AIR SEPARATORS

- A. Furnish and install as shown on the drawings a Caleffi (Basis of Design) coalescing type air eliminator and dirt separator on the hot and process water systems. All combination units shall be fabricated steel, rated for 150 psig working pressure with entering velocities up to 10 feet per second. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle may consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate medium is to be wound completely around and permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Separator shall have the vessel extended below the pipe connections an equal distance for dirt separation. Air eliminators shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.5% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.

2.5 ACCEPTABLE MANUFACTURERS – STRAINERS

- A. Armstrong
- B. Wheatley
- C. Keckley (Basis of Design)

- D. Reviewed equivalent

2.6 STRAINERS

- A. Size 2 ½ inch TO 8 inch: ASTM A126 Class B Cast Iron Body, 200 psi WOG at 150°F, Class 125, Y pattern, bolted screen retainer, off center blow down fitted with gate valve and plug. Provide stainless steel perforated screen for liquid service. Keckley Style A as Basis of Design.
- B. Size 2 inch and Under: Cast Bronze Body, 200 psi at 150°F, Class 125, Y pattern, screwed screen retainer, blow down fitted with gate vane and plug, threaded or screwed ends. Provide stainless steel perforated screen for liquid service. Keckley F-150 (screwed) and E-150 (solder joint) as Basis of Design.
- C. Well Water Basket Strainers: Flanged carbon steel (ASTM A216, Grade WCB) body rated for 200 psig working pressure, basket pattern with 1/8 stainless steel perforation screen and 80 mesh stainless steel screen, thumbwheel cover. Keckley SGFV-K as Basis of Design.
- D. 5 inch and larger Basket Strainers: Flanged carbon steel (ASTM A216, Grade WCB) body rated for 200 psig working pressure, basket pattern with stainless steel perforation screen for liquid service, thumbwheel cover. Keckley SGFV-K as Basis of Design.

2.7 ACCEPTABLE MANUFACTURERS – PUMP SPECIALTIES

- A. Metraflex (Basis of Design)
- B. Reviewed equivalent

2.8 PUMP SUCTION SPECIALTY

- A. Combination reducing elbow, flex connector and rotational vanes. Constructed of steel reducing elbow, ANSI Class 150 flanges and Type 304 stainless steel, close pitch corrugated hose with Type 304 stainless steel outer braided covering. Provide CRV vane that imparts a rotational motion as the fluid enters the elbow and counteract elbow induced turbulence enabling the fluid to turn uniformly and exit with a flat velocity profile. Rated for 190 psi at 70° F and 175 psi at 200° F. Metraflex CRV Flex as Basis of Design.

2.9 PUMP DISCHARGE SPECIALTY

- A. Combination increaser, flex connector and straightening vanes. Construct of steel increaser, ANSI Class 150 flanges and Type 304 stainless steel, close pitched corrugated hose with Type 304 stainless steel outer braided covering. Provide carbon steel straightening vane that reduces turbulence equal to 5-10 pipe diameters of straight pipe while allowing full movement of the connector. Rated for 190 psi at 70° F and 175 psi at 200° F. Provide carbon steel reducing elbow where required. Metraflex Vane Flex as Basis of Design.

2.10 ACCEPTABLE MANUFACTURERS – TRIPLE DUTY VALVES

- A. Bell and Gossett
- B. Paco (Basis of Design)
- C. Armstrong
- D. Weinman
- E. Reviewed equivalent

2.11 PUMP TRIPLE DUTY VALVE

- A. Valves: Straight or angle pattern, flanged cast-iron valve body bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation, repacking under line pressure.

2.12 ACCEPTABLE MANUFACTURERS – RELIEF VALVES

- A. Bell and Gossett
- B. Kunkle (Basis of Design)
- C. Watts
- D. Reviewed equivalent

2.13 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.14 ACCEPTABLE MANUFACTURERS – PRESSURE GAUGES

- A. Ashcroft 1009 (Basis of Design)
- B. Trerice 600CB
- C. Miljoco P4598L
- D. Weksler EA14
- E. Weiss 4CTS-1
- F. Reviewed equivalent

2.15 PRESSURE GAUGES

- A. Gauges shall be ASME B40-100, 4-1/2" diameter, stainless steel case, bronze bourbon tube, brass socket, acrylic/glass window, white dial with black pointer and numbers, liquid filled, 1% of full span accuracy, provide pressure, snubber, union and shut-off.
- B. For liquid fill, verify liquid and gauge compatibility for the operating temperature of the measured medium. Provide appropriate liquid fill: Glycerin for temperatures from 30 - 150°F, silicone for temperatures -30 to 240°F.
- C. Range: Comply with the following
 - 1. Vacuum: 30 inches Hg of vacuum to 15 psig pressure.
 - 2. Fluids under Pressure: Two times operating pressure.

2.16 ACCEPTABLE MANUFACTURERS – THERMOMETERS

- A. Trerice BX (Basis of Design)
- B. Miljoco SX935
- C. Weksler AA5H-9
- D. Weiss 9VU
- E. Reviewed equivalent

2.17 THERMOMETERS

- A. ASTM E1, industrial type, glass tubing, red reading, 9" long, cast aluminum with chrome front double strength glass, adjustable angle, organic liquid filled with magnifying lens, extended neck to clear insulation. Provide wells and separable sockets and oil or graphite heat transfer liquid.
- B. Scale Range:
 - 1. Hot Water: 30 to 240° F with 2° F scale division.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Provide manual air vents at system high points, at end of mains, at terminal return runouts and wherever are needed to purge entrained air. Provide automatic air vents where indicated.

- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide dirt/air separator on suction side of system circulation pump and connect to expansion tank, where indicated on the drawings.
- E. Provide pump specialties for centrifugal pumps.
- F. Provide pump triple valve on discharge side of constant speed base mounted centrifugal pumps. For VFD driven pumps, substitute a silent check valve and isolation valve.
- G. Support pump suction specialty with floor (base) mounted pipe and flange supports.
- H. Provide pressure relief valves on pressure vessels (including but not limited to) expansion tanks, buffer tanks, heat exchangers, and boilers.
- I. Select system pressure relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment pressure relief valve capacity to exceed rating of connected equipment.
- J. Pipe pressure relief valve outlet to nearest floor drain or trench drain. Piping shall be supported so that no stress is induced on the pressure relief valve.
- K. Provide isolation valves and balance valves at return line locations where branches tap off mains and sub-branches or as required for proper system isolation and balance and for future isolation and balancing ease due to building renovations. Provide isolation valves and balance valve at taps from risers at each floor.
- L. Locate specialties at accessible locations.
- M. Provide pressure gauges at the suction and discharge of each pump, at heat pumps, heat exchangers, filters, coils, etc. and where else required to monitor, troubleshoot and measure system water pressures; where indicated on the plans (or not) and control drawings. Provide additional snubber, as required to steady gauge readings. Locate gauges where dials can be easily read; provide pressure gauge cabinet where required for ease of reading.
- N. Provide thermometers and pressure gauges at all water source heat pumps, boilers, at heat exchanger supply and return, where pipes enter and exit mechanical rooms and where else required to monitor, troubleshoot and measure system water temperatures and pressures and where indicated on the plans (or not) and control drawings. Locate thermometers and pressure gauges where temperatures can be easily read. Locate thermometers where temperatures can be easily read.
- O. Provide thermometers at all main air handling unit coil runouts, at chiller, boiler and heat exchanger supply and return (both sides), at mixing valve locations, at mains entering or leaving mechanical rooms and where else required to monitor and measure system water temperatures and where indicated on the plans (or not) and control drawings. Locate thermometers where temperatures can be easily read. Locate thermometers where temperatures can be easily read.

- P. Provide strainers at inlet of pumps, chillers, condensers, control valves, on main lines, incoming water service (PRV) and where needed and not indicated on the diagrammatic plans. Provide a blowdown valve with capped chain and hose bibb at each strainer.
- Q. Provide specialties in accordance with details on the drawing and as required per manufacturer's recommendations and code regulations.

END OF SECTION 23 21 14

SECTION 23 21 16 - HYDRONIC PIPING AND VALVES (ABOVE GRADE)

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and pipe fittings
- B. Valves

1.2 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC
- C. Division 23 – Hydronic Specialties
- D. Division 23 – Hangers and Supports for HVAC Piping and Equipment
- E. Division 23 – Piping Insulation

1.3 REFERENCES

- A. ANSI/ASME – Boiler and Pressure Vessel Code
- B. ANSI/ASME Sec 9 – Welding and Bracing Qualifications
- C. ANSI/ASME B16.3 – Malleable Iron Threaded Fittings Class 150 and 300
- D. ANSI/ASME B31.9 – Building Services Piping
- E. ANSI/AWS A5.8 – Brazing Filler Metal
- F. ANSI/AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- G. ASTM A53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
- H. ASTM A234 – Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- I. ASTM B32 – Solder Metal

- J. ASTM B88 – Seamless Copper Water Tube

1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME B31.9.

1.5 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ANSI/ASME Sec. 9.
- C. Welders Certification: In accordance with ANSI/ASME Sec. 9.

1.6 SUBMITTALS

- A. Submit product data under provisions of Division 23 – Common Work Results for HVAC.
- B. Include data on pipe materials, pipe fittings, valves, and accessories.
- C. Include welder's certification of compliance with ANSI/ASME Sec. 9.

1.7 DELIVERY, STORAGE, PROTECTION AND HANDLING

- A. Deliver, store, protect and handle products under provisions of Division 23.
- B. Protect piping and specialties from contamination by leaving in shipping containers with all caps/plugs in place until time of immediate installation.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING ABOVE GRADE

- A. Steel Pipe: ASTM A53, Type ERW, Grade B, Schedule 40 for 10" and below, Standard (.375" wall) for 12" and above (both for welded joints). Use ASTM A53 or 120, Type S, Grade B, Schedule 40 for screwed joints. IPS Grooved Piping Systems are acceptable alternates according to 2.3 herein.
 - 1. Fittings: ANSI/ASTM B16.3, malleable iron Class 150 or ASTM A234, wrought steel welding type fittings, Schedule 40.
 - 2. Joints: Up to 2 inch, screwed; 2-1/2 inch and up, welded. Utilize fittings as specified above.
- B. Copper Tubing: ASTM B88, Type L, hard drawn, 2-1/2" and below.

1. Fittings: ANSI/ASME B16.23 cast brass or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA. Utilize fittings as specified above.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. PVC cannot be used in plenum areas.
- B. Steel Pipe: ASTM A53, Schedule 40 galvanized.
 1. Fittings: Galvanized cast iron, or ANSI/ASTM B16.3 malleable iron.
 2. Joints: Screwed, or grooved mechanical couplings, drainage pattern.
- C. Copper Tubing: ASTM B88, Type L hard drawn.
 1. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper, drainage pattern.
 2. Joints: ASTM B32, solder, Grade 95TA.

2.3 IPS GROOVED PIPING SYSTEMS

Victaulic grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods. All grooved components shall be of one manufacturer (Victaulic Company of America), and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA. Grooved end product manufacturer to be ISO-9001 certified. Grooved couplings shall meet the requirements of ASTM F-1476.

- A. Pipe/Grooved (Standard/Lightwall):

Carbon Steel, A-53B/A-106B – Roll grooved-ends with wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606.
- B. Victaulic Mechanical Couplings for Joining Carbon Steel Pipe:
 1. Victaulic Mechanical Couplings: Manufactured in two or more segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to physical properties of ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.
 - a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Victaulic Style 07 (Zero-Flex®), Style 107.
 - b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Couplings shall be placed in close proximity to the vibration source. Victaulic Style 75 or 77 or 177.

2. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741.
- C. Victaulic Grooved End Fittings: Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
- D. Victaulic Hole-Cut Branch Outlets:
1. Strapless Outlet: 1/2" or 3/4" NPT maximum outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Victaulic Style 923.
 2. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152 mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Victaulic Vic-O-Well Style 924.
- E. Victaulic Grooved End Valves:
1. Butterfly Valves
 - a. 2" through 12" Sizes: 300 psi (2065 kPa), grooved ends, polyphenylene sulfide (PPS) coated ductile iron body (ASTM A-536, Grade 65-45-12). Ductile iron disc, synthetic rubber encapsulated suited for the intended service, with integrally cast stem. Bubble tight, dead-end or bi-directional service. With memory stop for throttling, metering or balancing service. Lever handle for 6" and below worm gear operator for 8" and above. Victaulic Vic®-300 Butterfly Valve. Valves which are coated with epoxy or non-blow proof stems are not acceptable.
 - b. 14" through 24" Sizes: 175 psi (1270 kPa) / 300 psi (2065 kPa), grooved ends, polyphenylene sulfide (PPS) coated ductile iron body (ASTM A-536, Grade 65-45-12), PPS coated ductile iron disc (ASTM A-536), and two pieces 17-4 PH S/S stem design. Seat and seal material to suit intended service. Reinforced PTFE bearings and worm gear operator. Seat tested to MSS-SP-67. Bubble tight, dead-end, or bi-directional service. With memory stop for throttling, metering or balancing service. Victaulic Series 706 rated to 300 psi (2065 kPa) and Series 709 rated to 175 psi (1200 kPa). Valves which are coated with epoxy or non-blow proof stems are not acceptable.
- Note: Refer to latest published Victaulic literature, Butterfly Valve Material Selection section, for liner/seat and disc material recommendations for chemical service.
2. Check Valves:
 - a. 2-1/2" through 3" Sizes Spring Assisted: PPS coated ductile iron body, ASTM A-536, Grade 65-45-12, aluminum bronze non-slam tilting disc, stainless steel spring and shaft, rubber seat suitable for intended service, 300 psi (2065 kPa). Victaulic Series 716.

- b. 4" through 14" Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa). Victaulic Series 716.
 - c. 2" through 4" Sizes Horizontal Swing: Horizontal installation, ductile iron body, ASTM A-536, Grade 65-45-12, and Type 316 stainless steel clapper. Synthetic rubber bumper and bonnet seals suitable for intended service, stainless steel wetted parts, 300 psi (2065 kPa). Victaulic Series 779.
- 3. Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve. Vic®-300 butterfly valve assembled with Style 779 Venturi Check. Working pressures to 300 psi (2065 kPa). (Optional: Vic-Plug® valve Series 377 assembled with Style 779 Venturi Check. Working pressure to 175 psi (1200 kPa). Memory stops standard. Transition couplings Style 307 required for plug valve assembly.)
 - 4. Ball Valves: 1-1/2" through 6" sizes, ASTM A-536, Grade 65-45-12, ductile iron body, chrome plated carbon steel ball and stem, TFE seats, with Fluoroelastomer seals 800 psi (5515 kPa). Victaulic Series 726.
 - 5. Plug Valves: 3" through 12" sizes, with memory stop for throttling, metering or balancing service. Undirectional bubble-tight shut-off, bi-directional sealing optional, ductile iron body, bonnet, and plug, ASTM A-536, Grade 65-45-12. Plug encapsulated with synthetic rubber suitable for intended service. Welded-in nickel seat, stainless steel self-lubricating bearings. 175 PSI (1200 kPa). AWWA rigid groove dimensions may be adapted to IPS sized system through the use of Victaulic Style 307 transition couplings. Victaulic Series 377 eccentric plug balancing valves.
 - 6. Circuit Balancing Valves: Size all balancing valves to flow per the project schedule.
 - a. 2" and Smaller Sizes: Victaulic Koil Kits Series 799 or 79V may be used at coil connections. 300 psi (2065 kPa), threaded ends, non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronic Series 786/787H/78KH STAD.
 - b. 2-1/2" and Larger Sizes: 300 psi (2065 kPa), grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12 or 16 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronics Series 788/789 STAG.
- 7. Combination Balancing & Control Valve:
 - a. On/Off Control: Combination type, calibrated, non-ferrous Ametal® DZR brass copper alloy body, "Y" pattern globe style design. 1/2" through 1", 230 psi [16-bar] [1600 kPa], NPT female threaded ends, , PPS (polyphenylsulfide) plug, EPDM o-ring seat and spindle seal, stainless steel return spring, Nedox® coated Ametal® spindle, and 10-position setting dial. Suitable for working temperatures to +250°F (+120°C). Normally open and normally closed actuators shall be available factory installed. Basis of Design: Victaulic Series TC.
 - b. Modulating Control: Combination type, calibrated, non-ferrous Ametal® DZR brass copper alloy body, "Y" pattern globe style design. 1/2" through 1", 230 psi [16-bar] [1600 kPa], NPT female threaded ends, non-ferrous Ametal® DZR brass copper alloy body, PPS (polyphenylsulfide) plug, EPDM o-ring seat and spindle

seal, stainless steel return spring, Nedox® coated Ametal® spindle, and 10-position setting dial. Suitable for working temperatures to +250°F (+120°C). Normally closed actuators shall be available factory installed. Basis of Design: Victaulic Series TCM.

8. Pressure Independent Control & Balancing Valve
 - a. ½" – 6": The valve should be a control valve with adjustable, stepless, pre-settable balancing and built-in dp-controller. Test points shall be provided for measuring differential pressure and be integral with the body and incorporate means for positive leak tight shutoff when not in use. True flow measurement must be possible with balancing instrument. Threaded connections shall be NPT in accordance with ANSI/ASME B1.20.1-1983. Valve actuators shall be full modulating, low voltage (24VAC) and of the same manufacturer as the control valve.
9. In lieu of PIBCV, DP Controller can be used to isolate a zone to create pressure independence. Each terminal unit will then need a balancing and control valve.
 - a. ½" – 2": Series 793; for sizes 2-1/2" – 4": Series 794. Furnish differential pressure (dp) controllers where shown on drawings, paired-off with calibrated balancing valves of the same manufacturer, which will maintain the downstream differential pressure over the entire operating load range, ensuring stable and accurate control valve(s) modulation of flow. Construction: AMETAL (de-zincification resistant) brass copper alloy or ductile iron body, copper alloy bonnet, cone and spindles; stainless steel spring; EPDM rubber o-rings; HNBR rubber membrane.

F. Victaulic Grooved End Specialties

1. Expansion Joints:
 - a. 2" through 6" Sizes: Packless, gasketed, type with grooved end telescoping body, suitable for axial end movement to 3". 350 psi (2410 kPa). Victaulic Style 150 Mover®.
 - b. 3/4" and Larger Sizes: Expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint. Victaulic Style 155.
2. Dielectric Waterways: 1" through 8" sizes, grooved, plain end, or threaded end, ASTM A-53 carbon steel or ASTM A-536 ductile iron body, zinc electroplated, with LTHS high temperature stabilized polyolefin polymer liner. Victaulic Style 47.
3. Strainers – Grooved-End
 - a. T-Type Strainer: 2" and larger sizes, 300 PSI (2065 kPa) T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) or carbon steel (ASTM A-53) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" strainer sizes, or No. 6 mesh, 4"-16" strainer sizes, 57% free open area. Victaulic Style 730.

- b. Y-Type Strainer: 2" through 12" sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations and 41% open area 2"-3" strainer sizes or 1/8" (3,2mm) strainer sizes diameter perforations and 40% open area 4"-12" strainer sizes. Victaulic Style 732.
- 4. Suction Diffuser – Grooved/Flanged End. Rated to 300 psi (2065 kPa). Ductile iron (ASTM A-536) body. 304 stainless steel frame and perforated sheet diffuser with 5/32" (4,0mm) diameter holes 3" – 12" inlet sizes or 3/16" (4.8mm) diameter holes 14" and 16" inlet sizes. Removable 20 mesh 304 stainless steel start-up prefilter, outlets for pressure/temperature drain connections, and base support boss. Victaulic Series 731-G.
- 5. Flow Measuring Sensors – Grooved End
 - a. Venturi-Type: 2-1/2" and larger sizes, rated 250 psi (1725 kPa). Carbon steel (ASTM A-53) zinc electroplated body, brass needle valve conforming to ASTM B-124. Minimum straight pipe installation of five diameters upstream and two diameters downstream. Victaulic Style 733.
 - b. Orifice-Type: 2-1/2" and larger sizes, rated 250 psi (1725 kPa). Carbon steel (ASTM A-53) body and carbon steel (ASTM A-569) plate, brass needle valve conforming to ASTM B-124. Minimum straight pipe installation of five diameters upstream and two diameters downstream 2-1/2" through 4" sizes, and 10 diameters upstream and 4 diameters downstream in sizes 5" and larger. Victaulic Style 734.

G. Gaskets

- 1. Heating Systems – Victaulic Type E, EPDM, rated at -30 to 230° F.
- 2. Cooling Systems – Victaulic Type T, Nitrile, rated at -20 to 180° F.

H. Assembly

- 1. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove.
- 2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
- 3. See the latest copy of Victaulic's Field Assembly and Installation Instruction Pocket Handbook (I-100).
- 4. All grooved components (couplings, fittings, valves, gaskets, and specialties) shall be one manufacturer (Victaulic Company of America).
- 5. Victaulic shall provide on-site training for contractor's field personnel by a factory trained representative in the proper use of grooving tools, application of groove, and product installation. Victaulic's representative shall periodically visit the job site and inspect installation. The contractor shall remove and replace any improperly installed products.

2.4 PIPE NIPPLES

- A. Non-dielectric type – Extra heavy pipe of same material of adjacent installed pipe.

- B. Dielectric type – Electroplated steel pipe with thermoplastic lining, threaded ends, rated for minimum 300 psig and 225 service.

2.5 DIELECTRIC UNIONS

- A. Provide at copper (non-ferrous) to ferrous metal interface locations. Temperature and pressure rating of union shall equal or exceed the maximum temperature and pressure in which the union is installed. Dielectric unions shall be screwed for use in threaded lines, sweat for use in soldered lines or welded neck flanged ends for use in welded lines and shall withstand 600V on a dry line without flash-over. Central Plastic, EPCO Sales, Watts or reviewed equivalent.

2.6 GASKETS

- A. Ring type – ASME B16.21, 1/16" thick, factory cut, compressed, heat resistant for intended service, pressure rating per the intended service. All gaskets for flanges shall conform to the requirements set forth per ASME 31.1 and 31.9. Garlock or reviewed equivalent.

2.7 MECHANICAL WALL SEALS

- A. Provide mechanical wall seals at pipe penetrating exterior walls below grade or at pipe penetrating slabs in contact with grade. Seals shall be modular synthetic rubber type (low or high temp depending upon the pipe application) with interlocking links and mechanical compression via Type 316 stainless steel hardware. Thunderline "Link-Seal", Metraflex "MetraSeal" or reviewed equivalent by Wayne or Michigan.
- B. Pipe sleeves – ASTM A53, standard weight steel pipe, hot dipped galvanized finish.
- C. Escutcheon plates – 1 piece or split hinge plates, steel for unfinished locations. Polished stainless steel or chrome plated copper plates, 1 piece or split hinge for exposed locations.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe. Use emery cloth to remove oxidation at joint locations on copper tubing and fittings.
- B. Remove scale and dirt on inside and outside before assembly.
- C. After completion, flush, clean, rinse, clean strainers, and refill system.

3.2 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

- B. Water piping shall be tapped off the bottom of the pipe; provide all valves, tees, piping insulation, elbows and swing joints as required for hookup to coils or branches required by this work whether they are indicated on the drawings or not.
- C. Install piping to conserve building space, and not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for installation of insulation, and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
- H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Do not run piping through transformer vaults or other electrical or electronic equipment spaces and enclosures. Maintain 42" clearance from switchboards, panelboards and motor control centers.
- K. Mount all control valves, sensors, flow meters and devices under other sections.
- L. Connect to Equipment.

3.3 APPLICATION

- A. Install unions or flanges downstream of valves and at equipment or apparatus connections.
- B. Provide 3/4-inch gate or ball drain valves at, low points of piping, bases of vertical riser, and at equipment drain locations.

END OF SECTION 23 21 16

SECTION 23 21 23 - HVAC PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Pumps.

1.3 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 – Scope of Work
- C. Division 23 – Common Work Results for HVAC
- D. Division 23 – Vibration Isolation
- E. Division 23 – Facilities Management and Control System
- F. Division 23 – Hydronic Specialties

1.4 REFERENCES

- A. ANSI – American National Standards Institute
- B. ASTM – American Society for Testing and Materials
- C. ANSI/UL 778 – Motor Operated Water Pumps
- D. Hydraulics Institute
- E. NEMA – National Electrical Manufacturer's Association
- F. OSHA – Occupational Safety and Health Administration
- G. UL – Underwriters Laboratories, Inc.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 23.
- B. Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Pumps/motors are selected for additional friction head from scheduled; pumps shall meet Engineer's requirements. All pump motors shall be non-overloading within the entire range of the plotted pump curve and selected per the discretion of the Engineer. Submit multiple curves for parallel pumping arrangement with one, two or more system components in the loop (multiple system head curves plotted with the pump curve) and also submit variable speed curves. The Engineer has the final say if it is determined that substitute manufacturers do not meet proper system requirement nor have the proper characteristics for optimum performance of the hydronic systems. Failure to meet these requirements, then the Contractor shall submit the basis of design pumps.
- C. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- D. Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
- E. Submit Wiring Diagrams: Power, signal, and control wiring.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 23.
- B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers are listed for a quality assurance level only. Although a manufacturer is listed does not constitute compliance with the specification size, weight, functionality, capacity, noise, or performance levels. It is this contractor's responsibility to assure the proposed manufacturer has complete compliance with the Contract Documents, **prior to bidding**.
 - 1. Bell and Gossett
 - 2. Grundfos/Peerless
 - 3. Grundfos/Paco
 - 4. Armstrong
 - 5. Taco
 - 6. Aurora

2.2 GENERAL REQUIREMENTS

- A. Quiet operation, 1150, 1750 or 3500 RPM as scheduled, single stage, end suction, close or, flexible coupled as selected, serviceable without disturbing piping connections, factory tested,

cleaned and inspected. Rate pumps for 175 psig minimum working pressure and 225 degrees F continuous water temperature.

- B. Select pumps at 85% of maximum impeller diameter in casing.
- C. All motors shall be non-overloading within the entire range of the plotted pump curve. Pumps/motors are selected for additional friction head from scheduled; pumps shall meet Engineer's requirements.

2.3 END SUCTION PUMPS

- A. The contractor shall furnish and install as shown in the plans and described in these specifications, high performance end suction pumps designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).
- B. Casing – Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet, with a replaceable lead free bronze case wear ring. All pumps shall be of the back pull out design so that the rotating element can be removed from the casing without disconnecting the suction or discharge piping.
- C. Impeller – The impeller shall be a cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2016 balance grade G6.3 and secured to the shaft by a locking cap screw or nut. Impeller diameter shall be trimmed for the specific design conditions.
- D. Shaft Sealing – The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F (107°C). A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
- E. Motor – Premium efficient motor shall be of the horsepower and speed shown in the pump schedule. Pumps requiring larger horsepower shall not be acceptable. Pump shall be close coupled to a horizontal ODP motor with 1.15 service factor. 40°C ambient. Motors that are VFD driven shall have shaft grounding.
- F. Cast Iron Base (Close Coupled) – To ensure full benefit of the pump back pull-out feature, entire pumping unit shall be mounted on a cast iron drip rim base using cap screws. Pumps shall not be secured with floor studs.
- G. Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2019 for grouted Horizontal Baseplate Design standards.
- H. A flexible type, center drop-out design coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. The coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.

- I. Energy Evaluation – If pumps other than those in the schedule are offered, the pump supplier shall submit an energy evaluation for the engineer's approval prior to manufacture of the pumps. This evaluation shall compare proposed equipment to the specified efficiency and show that the total job operating cost will be lower or meet the operating cost at specified efficiency.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 requirements.
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 INSTALLATION

- A. Install pumps in accordance with manufacturer's instructions.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- E. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- F. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-over loading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- G. Mount pumps on vibration isolation inertia bases. Refer to Division 23.
- H. Ground Motor Shafts for VFD driven pumps.
- I. Fill all pumps and/or prime prior the “bump test” (verification of correct rotation). Coordinate with the electrical contractor. Do not energize pump motor without pump being full of fluid.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. On Suction side decrease from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow. Support piping adjacent

to pump such that no weight is carried on pump casings. For end suction pumps, provide supports under suction diffuser.

- F. Provide line sized gate or ball valve, strainer with blowdown valve, increase/reducer, pressure gauge, and Flexhose Pumpsaver SMP flex connector. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller and a pressure gauge, increaser/reducer, Flexhose Pumpsaver SMP flex connector and a triple duty valve on the discharge line of all constant speed pumps. Substitute butterfly for gate valve on chilled and condenser water systems. Substitute isolation valve and silent check valve for triple duty valve for pumps that are VFD driven. Locate strainer with blowdown valve on discharge side of pump for pumps within open condenser water systems.
- G. Install Flexhose pump flexible connectors on suction and discharge sides of base-mounted pumps; install between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install electrical connections for power, controls, and devices.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding."
- K. Connect wiring according to Division 26 Section "Conductors and Cables."
- L. Provide air cock and drain connection on pump casings.
- M. Provide drains for bases and seals, piped to and discharging into floor drains.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup check according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Cleaning of piping system
- B. Chemical feeder equipment
- C. Treatment for closed systems (heating, hot water)

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Division 23 – Hydronic Piping: Bypass pot feeder
- B. Water Softeners

1.3 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 23. Indicate materials, chemicals and equipment.
- B. Submit reports indicating start-up of treatment systems is completed and operating properly.
- C. Submit reports indicating analysis of system water after cleaning and after treatment.
- D. Submit detail power and control wiring diagrams.
- E. Submit a copy of water analysis.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01 and 23.
- B. Include data on chemical feed pumps, agitators and other equipment including spare parts lists, procedures and treatment programs.

- C. Include step-by-step instructions on test procedures including target concentrations.

1.6 REGULATORY REQUIREMENTS

- A. Conform to code for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.
- B. References: The vendor should supply the names and phone numbers of five school district references serviced by the local representative. In addition, the names and phone numbers of two school facilities that are using the programs recommended in this proposal shall be supplied with bid.
- C. Account Manager: The local representative should have ten (10) years experience in the field of water treatment. This representative shall hold a minimum of a BS in Chemistry or Engineering and be a Certified Water Technologist by The Association of Water Technologies.
- D. Alternate Account Manager: Another member of the vendor's staff who is thoroughly familiar with the plant must have the same qualifications. He will visit the plant periodically with the account manager to maintain a working knowledge of the systems.
- E. Service Technicians: Field service technicians shall have three (3) years experience in the field of water treatment. The vendor will supply written documentation to verify formal training in boiler and cooling water treatment and water treatment equipment maintenance and repair.
- F. Qualifications: A resume shall be submitted with bid document for assigned account manager and technicians.

1.7 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Final Acceptance.
- B. Provide three technical service visits to perform field inspections and make water analysis on site during the first year. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit to Architect/Engineer.
- C. Provide laboratory and technical assistance services for warranty period.
- D. Include two-hour training course for operating personnel, instructing them on installation, care, maintenance, testing and operation of water treatment systems. Arrange course at startup of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

F. Water Treatment Equipment Maintenance

1. The vendor shall be responsible to maintain all water conditioning, control and chemical feed equipment. Major repairs such as chemical pumps, softeners and controllers are not covered. Trained technicians shall be full-time employees of the vendor. Vendor shall respond to service calls for maintenance or repair within forty-eight (48) hours.

1.8 MAINTENANCE MATERIALS

- A. Submit maintenance materials under provisions of Division 01 and 23.
- B. Provide sufficient chemicals for treatment and testing during warranty period.
- C. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the cooling, chilled-water piping, heating, hot-water piping, heating, steam and condensate piping, steam and condensate system for humidifier and cooking appliance applications, condenser water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Final Acceptance, including the following:
 1. Initial water analysis and recommendations
 2. Startup assistance
 3. Periodic field service and consultation
 4. Customer report charts and log sheets
 5. Laboratory technical assistance
 6. Analysis and reports of all chemical items concerning safety and compliance with government regulations.

1.9 PERFORMANCE REQUIREMENTS

- A. Program Objectives
 1. Minimize corrosion, deposition and biological fouling.
 2. Minimize or eliminate, where possible, chemical handling by district personnel.
 3. Minimize water use and sewer discharge by operating systems at maximum cycles of concentration using best available technologies.
 4. Reduce overall energy consumption through optimum heat transfer efficiency.
 5. Train district personnel in the implementation and control of the water treatment program.
 6. Provide monitoring and reporting of program results to insure all program objects are being met.
 7. Provide competitive program cost.
- B. General Instructions
 1. Vendor shall supply, deliver and apply where specified, all chemicals and services necessary to treat all systems listed in Schedules A. Monthly sampling, analysis, and maintenance of all chemical feed equipment will be the vendor's responsibility. Vendor is responsible for collecting water samples from each location. Conditioning, control and

complete field service reports will be left with designated personnel upon each visit to facility.

C. Types of Service

1. Vendor will provide the following water treatment service – full service. Cooling towers, heat pumps with evaporative cooling towers, steam and hot water boilers, closed condensers and chilled loop piping systems will be, full service. Minimum frequency shall be monthly for all systems.

D. Full Service (Schedule A)

1. The following is a list of minimum services to be provided under full service agreement.
 - a. Furnish, deliver, and apply all chemicals.
 - b. Qualified technicians will service the systems as specified.
2. During each visit the technician will perform the following services as a minimum.
 - a. Inspect and maintain all water treatment control and feed equipment.
 - b. Collect and analyze samples on-site of all systems treated.
 - c. Make all necessary adjustments to feed rates on the basis of field tests.
 - d. Collect samples of all systems for laboratory analysis in vendor laboratory.
 - e. Prepare a written field service report at the time of visit and review said report with the Director of Plant Management, Maintenance Crew Leader or their designee.
 - f. Notify designated personnel of any needed systems repairs that the water treatment tests show are the result of deficiencies in the mechanical systems, such as, excessive water loss.

E. Water Treatment Operating Parameters

1. Vendor shall provide products and services designed to maintain the following system parameters.

Closed Loops (Hot, Chilled and H. Pump)	
pH	9.0 – 10.0 units
Chilled and H.P.	400 – 800 ppm (Nitrite)
Hot, Dual Reheat	800 – 1200 ppm (Nitrite)
Total Plate Count	<10 ¹ CFU/ML

F. Closed Loops

1. Vendor shall provide a liquid blend of buffer nitrite and tolytriazole inhibitors to maintain specified parameters. A liquid blend of 45% glutaraldehyde shall be applied as required to maintain the specified biological operating parameters.

G. Regulatory Compliance

1. Products supplied shall comply with all regulations pertaining to chemicals. This will include DOT, OSHA, NIOSH and local and state regulatory agencies. MSDS Sheets

shall be displayed for all products on site at point of application in a 3 ring binder labeled as to the content. Boiler water additives shall meet FDA compliance requirements.

1.10 CHEMICAL DELIVERY AND STORAGE

- A. Vendor shall deliver all chemicals to each location and store in designated areas.
- B. Vendor shall be responsible for delivery of all material. Due to the type of facilities, trucks should be equipped with power tailgates and drivers, are required to be trained in safe and proper handling of chemicals to be supplied. Vendor shall be responsible for removal and proper disposal or recycling of all empty containers.

1.11 WATER ANALYSIS

- A. On a minimum monthly basis, the following water analysis shall be performed and results reported with recommendations.
 - 1. Raw Water
 - a. pH, total hardness, p. alkalinity, m. alkalinity, chloride, silica, iron, copper, phosphate (ortho and total).
 - 2. Closed Loops
 - a. pH, TDS, nitrite, iron, copper.
- B. Biological testing on the cooling tower shall be conducted at least once monthly. With Legionella testing performed annual on the domestic hot water systems and cooling towers.
- C. Biological testing on closed loops shall be conducted as required in the event of an indication that biological fouling is occurring. Testing shall be continued until control is established

1.12 REPORTING

- A. Field Reports
 - 1. All vendor personnel should notify the designated supervisory school personnel upon arrival, for any purpose, at facility. A written report shall be submitted to school designee at the completion of any site visit. Reports of monthly field service shall include test results, chemical used, water use, work performed, discussion of conditions found and recommendations. Field report shall be reviewed with and signed by designated supervisory personnel.
- B. Laboratory and Management Reporting
 - 1. Following each monthly field service samples of all systems treated will be analyzed at vendor laboratory in accordance with AWWA standard methods. Lab results and field reports shall be reviewed by account manager and a complete report, including laboratory

results, forwarded to designated hospital management personnel within ten (10) days of sample collection.

1.13 TRAINING

- A. Vendor will schedule minimum of semi-annual training seminars to continuously improve the knowledge of your operating personnel in the field of water treatment.
- B. This training will include as a minimum the following:
 - 1. Principals of water treatment.
 - 2. Chemical testing and control procedures for all treated systems.
 - 3. Equipment operation and maintenance.
 - 4. Troubleshooting.
 - 5. Safety and handling chemicals including M.S.D.S. information.
 - 6. New technologies and developments in the water treatment industry.

Vendor shall make available interactive CD-ROM based training on both boiler and cooling water treatment for use by district personnel. CD-ROM Disc shall remain the property of the vendor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Klenzoid (Basis of Design)
- B. Nalco
- C. Amrep
- D. Reviewed equivalent

2.2 MATERIALS

- A. System Cleaner
 - 1. Concentrated liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate. Amrep AmSolv 9350.
 - 2. Algaecide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis thiocyanate, or isothiazolones.
- B. Closed System Metal Passifier
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.

2. Corrosion inhibitors; liquid boron-nitrate, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.
4. Amrep AmTreat 084K.

2.3 EQUIPMENT

- A. By-pass Pot Feeder: 7.5 gallon with 3-1/2" diameter wide-mouth quick opening epoxy coated cap with gasket for working pressure of 300 psig, ASME rated, steel construction with supply return, pressure gauge and vent tappings, integral taps, six 20 micron filter bags supported by a stainless steel filter basket for simultaneous side stream filtering. Neptune FTF-5CL.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems will be operational, filled, started and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.2 CLEANING SEQUENCE

- A. Add cleaner to closed systems at concentration as recommended by manufacturer.
- B. Hot Water Heating Systems: Apply heat while circulating, slowly raising temperature to 160° F and maintain for 12 hours minimum. Remove heat and circulate to 100° F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
- D. Remove, clean and replace strainer screens.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on the heating water system. Install isolating and drain valves and necessary piping. Install around pump triple-duty valve.

- B. Introduce closed system treatment through bypass feeder when required or indicated by test.

3.5 ADJUSTING

- A. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 370 and the following standards:
 - 1. Silica: ASTM D 859.
 - 2. Steam System: ASTM D 1066.
 - 3. Acidity and Alkalinity: ASTM D1067.
 - 4. Iron: ASTM D1068
 - 5. Water Hardness: ASTM D1126.
- B. Occupancy of Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain HVAC water-treatment systems and equipment.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment and schedules.
- B. Review manufacturer's safety data sheets for handling of chemicals.
- C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.
- D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 01 Section "Operation and Maintenance Data."
- E. Schedule at least four hours of training with the Owner, through Architect, with at least seven days advance notice.

END OF SECTION 23 25 00

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Low pressure ductwork
- B. Medium and high-pressure ductwork

1.2 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC
- C. Division 23 – Supports and Anchors: Sleeves
- D. Division 23 – Duct Insulation
- E. Division 23 – Ductwork Accessories

1.3 REFERENCES

- A. ASHRAE – Handbook 1989 Fundamentals; Chapter 33 – Duct Design
- B. ASHRAE – Handbook 1988 Equipment; Chapter 1 – Duct Construction
- C. ASTM A 90 – Weight of coating of Zinc-Coated (Galvanized) Iron or Steel Articles
- D. ASTM A 167 – Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip
- E. ASTM A 525 – General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
- F. ASTM A 527 – Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality
- G. ASTM B209 – Aluminum and Aluminum Alloy Sheet and Plate
- H. NFPA 90A – Installation of Air Conditioning and Ventilating Systems
- I. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems
- J. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment

- K. SMACNA – Duct Construction Standards
- L. UL 181 – Factory-Made Air Ducts and Connectors

1.4 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, main sizes inside lining.
- B. Low Pressure: Three pressure classifications: 1/2 inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.
- C. Medium Pressure: Three pressure classification: 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm, 4 inch WG positive static pressure and velocities greater than 2,000 fpm, 6 inch WG positive static pressure and velocities greater than 2,000 fpm.
- D. High Pressure: 10 inch WG positive static pressure and velocities greater than 2,000 fpm.

1.5 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A and NFPA 96 standards.

1.6 SUBMITTALS

- A. Submit shop drawings under provisions of Division 01 and 23.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work. Provide detailed layout drawings showing each duct fitting. The minimum acceptable scale is 1/4 inch equals 1 foot.
- C. Provide mockups of ductwork indicating construction, sealing methods, reinforcement and methods, longitudinal and traverse joint methods, elbows with turning vanes, fittings, volume/smoke/fire/combination fire/smoke dampers installation and appurtenances. Mockups may be actual ductwork segments utilized for the project. Mockups are subject to analysis by the Engineer for conformance to these specifications and details on the contract documents.
- D. Structural steel fabricator and installer shall be responsible for the coordination of all framed openings in roof with approved equipment manufacturers. (Openings such as, but not limited to mechanical units, exhaust fans, curb mounted equipment, roof drains, skylights, stair openings, roof hatches, smoke hatches, duct through roof penetrations, expansion joints, etc.) Exact sizes and exact locations of all openings are to be verified with the approved shop drawings issued for the installation. The exact sizes shall be coordinated prior to any fabrication and installation by any/all trades. Sizes and locations indicated on Contract Drawings are diagrammatic and for information only. Any fabrication and/or installation which has not been properly coordinated with approved equipment manufacturer and must be repaired, relocated, altered, replaced, reinstalled or modified in any manner will be done to the satisfaction of the Owner with no additional cost to the Owner or design professional.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All ductwork and ductwork accessories in or near the pool area (connected to PDU-1, ERU-3, RTU-2, or EF-2) shall be all aluminum construction.
- B. All ductwork connected to EF-1 shall be high density polyethylene (HDPE) blue duct (No Substitutions).
- C. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- D. Actual gauge sheetmetal shall be utilized for ductwork. Sheetmetal that is out of tolerance shall not be used on the project.
- E. Steel Ducts: ASTM A 527 galvanized steel sheet, lock-forming quality, having zinc coating of .90 oz. per sq. ft. for each side in conformance with ASTM A90. Ductwork that is exposed for painting shall be galvanized.
- F. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- G. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F, R-8. 10 year parts and labor warranty against blow-out. Thermaflex G-KM. Provide insulated Thermaflex FlexFlow elbows at diffuser locations.
- H. Fasteners: Rivets, bolts, or sheet metal screws.
- I. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; heavy mastic, water-based, less than 50/25 smoke developed/flame spread per ASTM E84. Ductmate Pro Seal.
- J. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- K. Seal all ducts in accordance with SMACNA Duct Construction Standards. All joints, longitudinal and transverse seams and connections in ductwork, shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded fabric systems, or tapes. Tapes and mastics used to seal ductwork shall be listed and labeled in accordance with UL 181A or UL 181B. Duct connections to flanges of air distribution system equipment shall be sealed and mechanically fastened. Unlisted duct tape shall not be permitted as a sealant on any metal ducts. Utilize Pittsburgh lock longitudinal seams for rectangular ducts and fittings through 18 gauge material. Utilize welded seams for rectangular ducts 16 gauge and up.
- L. Duct hangers and supports shall be in accordance with the SMACNA HVAC DUCT CONSTRUCTION STANDARDS - METAL AND FLEXIBLE. Ducts shall be supported with approved hangers at intervals not exceeding 10 feet or by any other approved hangers systems

designed in accordance with the International Building Code. Flexible and other factory made ducts shall be supported in accordance with the manufacturer's installation instructions.

2.2 BLUE DUCT SPECIFICATION: PRODUCTS – UNDERGROUND DUCTWORK

A. Acceptable Manufacturers:

1. The BlueDuct® by AQC Industries, Roseville, MN 55126, (877-783-1520). www.aqcind.com and e-mail: team@aqcind.com

B. Underground Duct

1. Complete duct system (including inlet plenums, round duct, run-outs, diffuser boots, etc.) must be from one manufacturer and be of the same material, construction and connection method throughout. Field made duct components are NOT acceptable.
2. Provide elbows, ducts, diffuser boxes, plenums, clamp & gaskets, boots, and caulk as required.
3. All duct and fittings shall be constructed per SMACNA's Duct Construction Standards to withstand +10" w.g. and -2" w.g.
4. Ductwork shall be closed cell plastic material that is recyclable, does not emit volatile organic compounds, and conforms to ASTM-D2412. Ductwork shall be resistant to mildew, mold (UL 181B), and radon gas (BSS 7239-88). Ductwork shall not rust or crack under external stress or strain. Ductwork shall have integral R-10 equivalent thermal insulation value, without the use of external insulation, per NSF's P374 Protocol and verified by a NSF Thermal Testing Report.
5. All joints shall be sealed via gasket or bolts and sealant.
6. Clamps and gaskets shall be used on ductwork without flanges. Clamps shall be polyethylene with stainless steel plates and stainless-steel screws. Gaskets shall comprise of ¼" thick butyl rubber sealant tape that is water and UV resistant and shall not stain. Gaskets shall comply with ASTM-E84 for flame and smoke spread.
7. Flanged joints and duct branches shall use a co-polymer adhesive caulking sealant that is water and UV resistant. Flanges shall be connected with stainless steel bolts.
8. Assembled ductwork shall be able to maintain pressure with no leakage.
9. Fiberglass style (FRP) ductwork or PVC coated galvanized steel ductwork shall NOT be acceptable.
10. Duct system performance shall exceed SMACNA's Leakage Class 1 requirements at the system design static pressure.
11. Duct system shall carry a 10-year Limited Warranty.

2.3 LOW PRESSURE DUCTWORK

- ### A.
- Fabricate and support in accordance with SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated herein. Utilize heavier duct gauges with no stiffeners required whenever possible, in compliance with SMACNA Duct Construction Standards. Use of lighter duct gauges with stiffeners shall not be used unless approved by the Engineer prior to installation.

- B. Size round and oval ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular, oval and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on the inside radius. Where not possible and where rectangular elbows are used, provide Aero Dyne HEP turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two duct maintaining original duct area.
- F. Connect flexible ducts to metal ducts with draw bands.
- G. Use double nuts and lock washers on threaded rod supports.
- H. All longitudinal joints shall be of the Pittsburgh lock type. Provide an additional application of sealant on the airstream side of the joint of all ducts.
- I. Use Buckley ATMD fittings on taps to diffusers. Fittings to have adhesive neoprene gasket, integral volume damper and extended neck/quadrant lock. Secure with multiple sheetmetal screws.

2.4 MEDIUM AND HIGH-PRESSURE DUCTS

- A. Fabricate and support in accordance with SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated herein. Utilize heavier duct gauges with no stiffeners required whenever possible, in compliance with SMACNA Duct Construction Standards. Use of lighter duct gauges with stiffeners shall not be used unless approved by the Engineer prior to installation.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide (airfoil) turning vanes; refer to Div 23 Ductwork Accessories for turning vane specifications.
- C. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
- D. Duct mate joints shall be used on supply, return and exhaust. Apply sealant to inside and outside of flange joint/duct joint.
- E. Provide standard 90 degree lateral wye takeoffs with 45 degree inlet edge. Conical tee connections may be used.

- F. Round and oval ductwork may be used in lieu of rectangular. Air velocity may not be increased. Acceptable manufacturer is United McGill. Clearances must be verified and considered where conflicts occur.
- G. Use double nuts and lock washers on threaded rod supports.
- H. All longitudinal joints shall be of the Pittsburgh lock type, with appropriate sealant applied to the joint during assembly. Apply another application of sealant on the airstream side of the joint.
- I. Use Buckley M-BM fittings on taps to CV or VAV boxes. Fittings to have neoprene gasket and mini-bellmouth tap configuration. Secure to duct with multiple sheetmetal screws.

2.5 DUCT CONSTRUCTION STANDARDS

- A. Pressure Class: 1" WG Pos. or Neg.
Material: Galvanized, G90 grade
Standard Joint: 55 3/4" (18 gauge – 24 gauge)
Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
Joint Types: 8" Duct dimension or less: S-Lock and Drive
Greater than 8" dimension: TDF flange and gasket.
No additional reinforcement unless noted.
Duct Reinforcing: 3/4" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
30" – Down	24	24	24	24	24
31" – 36"	24	24	24	24	24
37" – 42"	24	24	24	24	24
43" – 48"	A	24	24	24	24
49" – 54"	A	A	24	24	24
55" – 60"	A	A	22	24	24

61" – 72"	B	B	22	22	22
73" – 84"	J	J	C	C	C
85" – 96"	F	J	E	E	C
97" – Up	\\\\\\	H	G	G	G

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

- B. Pressure Class: 2" WG Pos. or Neg.
- Material: Galvanized, G90 grade
- Standard Joint: 55 ¾" (18 gauge – 24 gauge)
- Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
- Joint Types: 8" Duct dimension or less: S-Lock and Drive
Greater than 8" dimension: TDF flange and gasket.
No additional reinforcement unless noted.
- Duct Reinforcing: ¾" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
26" – Down	24	24	24	24	24
27" – 28"	24	24	24	24	24
29" – 30"	24	24	24	24	24

31" – 36"	22	24	24	24	24
37" – 42"	20	22	24	24	24
43" – 48"	18	20	22	22	24
49" – 54"	J	J	20	22	22
55" – 60"	D	J	20	20	22
61" – 72"	H	D	J	J	18
73" – 84"	\\\\\\	D	E	C	C
85" – 96"	\\\\\\	G	G	E	E
97" – Up	\\\\\\	\\\\\\	G	G	G

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

- C. Pressure Class: 3" WG Pos. or Neg.
- Material: Galvanized, G90 grade
- Standard Joint: 55 ¾" (18 gauge – 24 gauge)
- Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
- Joint Types: TDF flange and gasket.
No additional reinforcement unless noted.
- Duct Reinforcing: ¾" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
12" – Down	24	24	24	24	24
13" – 18"	24	24	24	24	24
19" – 26"	24	24	24	24	24
27" – 28"	22	24	24	24	24
29" – 30"	22	A	24	24	24
31" – 36"	20	22	22	24	24
61" – 72"	D	D	C	C	22
73" – 84"	\\\\\\	D	G	E	C
85" – 96"	\\\\\\	F	G	G	E
97" – Up	\\\\\\	\\\\\\	\\\\\\	G	G

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

- D. Pressure Class: 4" WG Pos. or Neg.
- Material: Galvanized, G90 grade
- Standard Joint: 55 ¾" (18 gauge – 24 gauge)
- Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
- Joint Types: TDF flange and gasket.
No additional reinforcement unless noted.

Duct Reinforcing: ¾" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
12" – Down	24	24	24	24	24
13" – 18"	24	24	24	24	24
19" – 22"	24	24	24	24	24
23" – 28"	22	24	24	24	24
29" – 30"	C	22	24	24	24
31" – 36"	E	C	22	22	24
37" – 42"	D	D	C	C	22
43" – 48"	D	D	C	C	C
49" – 54"	D	D	E	C	C
55" – 60"	D	D	E	C	C
61" – 72"	F	D	G	E	C
73" – 84"	\\\\\\	F	G	E	E
85" – 96"	\\\\\\	F	\\\\\\	G	E
97" – Up	\\\\\\	\\\\\\	\\\\\\	G	G

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

- E. Pressure Class: 6" WG Pos. or Neg.
- Material: Galvanized, G90 grade
- Standard Joint: 55 ¾" (18 gauge – 24 gauge)
- Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
- Joint Types: Through 18 ga: TDF flange and gasket.
16 ga: Manufactured Flange
No additional reinforcement unless noted.
- Duct Reinforcing: ¾" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
12" – Down	24	24	24	24	24
13" – 18"	22	24	24	24	24
19" – 20"	22	24	24	24	24
21" – 24"	22	22	24	24	24
25" – 26"	20	22	24	24	24
27" – 28"	20	C	22	22	24
29" – 30"	18	C	22	22	24
31" – 36"	18	20	C	22	24
37" – 42"	D	D	E	C	C
43" – 48"	F	D	D	C	C
49" – 54"	F	D	D	E	C
55" – 60"	F	D	G	G	C
61" – 72"	H	F	F	G	E
73" – 84"	\\\\\\	\\\\\\	\\\\\\	G	G
85" – 96"	\\\\\\	\\\\\\	\\\\\\	G	G

97" – Up	\\\\\\	\\\\\\	\\\\\\	16	16

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

- F. Pressure Class: 10" WG Pos. or Neg.
- Material: Galvanized, G90 grade
- Standard Joint: 55 ¾" (18 gauge – 24 gauge)
- Seams: Longitudinal Pittsburgh seams for all ducts and fittings
All longitudinal seams sealed.
- Joint Types: Through 18 ga: TDF flange and gasket.
16 ga: Manufactured Flange
No additional reinforcement unless noted.
- Duct Reinforcing: ¾" EMT conduit & Condu-Lock,
Max spacing 30" on center.

DUCT GAUGE/REINFORCEMENT					
Duct Dimension	Duct Length				
	49" – 60"	37" – 48"	31" – 36"	25" – 30"	24" - Down
8" – Down	24	24	24	24	24
9" – 12"	22	24	24	24	24
13" - 18"	20	20	24	24	24
19" - 22"	18	20	22	22	24
23" – 26"	18	E	C	22	22
27" – 28"	G	18	C	C	22

29" – 30"	16	G	C	C	C
31" – 36"	16	G	C	C	C
37" – 42"	\\\\\\	16	G	E	E
43" – 48"	\\\\\\	\\\\\\	G	G	E
49" – 54"	\\\\\\	\\\\\\	16	G	E
55" – 60"	\\\\\\	\\\\\\	16	G	E
61" – 72"	\\\\\\	\\\\\\	\\\\\\	16	G
73" – 84"	\\\\\\	\\\\\\	\\\\\\	\\\\\\	16
85" – 96"	\\\\\\	\\\\\\	\\\\\\	\\\\\\	16
97" – Up	\\\\\\	\\\\\\	\\\\\\	\\\\\\	16

TABLE KEY:

1. A - 24 ga with tie-rods in center
2. B - 22 ga with tie-rods in center
3. C - 22 ga with tie-rods in ends
4. D - 22 ga with tie-rods in center and ends
5. E - 20 ga with tie-rods in ends
6. F - 20 ga with tie-rods in center and ends
7. G - 18 ga with tie-rods in ends
8. H - 18 ga with tie-rods in center and ends
9. J - 18 ga with no reinforcement or 22 ga with tie-rods in center and ends
10. \\\\ - Not Designed

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall include allowances for structural, piping, and conduit interferences not evident during the bid phase or indicated on the drawings. Interferences are to be worked out during the shop drawing phase.
- B. Contractor to take special care of shipping, handling and assembly of ductwork.
- C. Provide offsets at interference locations and/or where changes in ceiling heights require such offsets; offsets shall be smooth as possible and without the need for hard elbows; offsets shall minimize the elbow/offset angle required which shall result in minimal static pressure gradients into the system.

- D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. All ductwork openings shall be covered, protected and sealed against contaminant migration into the airstream and shall be covered by plastic. Plastic to be removed upon continuation of work. Maintain integrity of protection as the work progresses.
- G. Use 24 inch minimum length, straight sheet metal duct directly adjacent to inlets at terminal boxes.
- H. Connect diffusers and grilles (exhaust and return) to low pressure ducts with 8 feet maximum length of straight run insulated flexible duct. Hold in place with strap or clamp. Flex duct shall be supported such that the installation is in kink-free manner. Use Thermaflex FlexFlow elbows at all air inlet and outlet connection to flex ducts.
- I. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- J. Install Buckley fittings per manufacturer's instructions. Secure with sheet metal screws.
- K. Where ductwork is exposed to weather, provide .060" thick EPDM membrane adhered to the ductwork.

3.2 DUCTWORK MATERIAL SCHEDULE

AIR SYSTEM	MATERIAL
Supply, Return, Relief and Intake	G90 Steel
General Exhaust	G90 Steel

3.3 DUCTWORK PRESSURE CLASSIFICATION

SYSTEM	CLASSIFICATION
Ductwork: Within equipment room	Medium Pressure; 4 inch; Seal Class A
Ductwork: Main return	Medium Pressure; 4 inch; Seal Class A
Ductwork: Equipment room wall to terminal unit	Medium Pressure; 4 inch; Seal Class A
Ductwork: Terminal unit to air outlet	Low Pressure; 1 inch
Ductwork: Branch return and general exhaust	Low Pressure; 2 inch, Seal Class A
Ductwork: General Exhaust <1"	Low Pressure, 1 inch

3.4 DUCTWORK LEAKAGE TESTING

- A. The Contractor shall not insulate the systems until leakage tests have been performed and results accepted.
- B. The Contractor shall, at the beginning of the work, construct, erect and leak test a representative sample of the duct construction to be used which is designed to operate at static pressures 3" wg and above. The sample specification shall be at least 25% of the entire system which shall include at least five transverse joints, two typical seams, an access door, typical branch connections, at least one elbow and two fire or fire/smoke dampers. All shafts/risers shall be leak tested prior to insulating and enclosing.
- C. The pressure testing shall be performed in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, latest edition.
- D. The leakage amount shall not exceed the allotted amount for the pressure class or the allotted amount for that portion of this system, whichever is applicable.

DUCT CONSTRUCTION CLASS	RATE OF AIR LEAKAGE (C _L)
10" wg	3
6" wg	6
4" wg	6
3" wg	6

The Rate of Air Leakage (C_L) of the sample specimen shall be determined by the formula $(C_L) = F/P^{.65}$ where F is the measured leakage rate in cfm/100 sq. ft. duct area and P is the static pressure of the test.

- E. If the sample specimen fails to meet the allotted rate of air leakage (C_L), the Contractor shall modify to bring it into compliance and shall retest it until the acceptable leakage level is demonstrated. Excessive buttering with duct sealant is prohibited.
- F. Tests and necessary repair shall be completed prior to the installation of insulation and concealment of ductwork.

END OF SECTION 23 31 13

SECTION 23 33 10 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Volume control and shut off dampers
- C. Air turning vanes
- D. Flexible duct connections
- E. Duct access doors
- F. Duct test holes

1.2 RELATED WORK

- A. Division 23 – HVAC Scope of Work
- B. Division 23 – Common Work Results for HVAC
- C. Division 23 – Ductwork
- D. Division 23 Section "Fire Alarm" for duct-mounting fire and smoke detectors
- E. Division 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 REFERENCES - (LATEST EDITION)

- A. AMCA 500-D – Laboratory Methods for Testing Dampers for Ratings
- B. AMCA 511 – Certified Ratings Program for Air Control Devices
- C. IBC – International Building Code
- D. NFPA 90A – Installation of Air Conditioning and Ventilating Systems
- E. NFPA 92A – Smoke Control Systems
- F. NFPA 92B – Smoke Control Systems in Atria, Covered Malls and Large Areas

- G. NFPA 101 – Life Safety Code
- H. SMACNA – Duct Construction Standards
- I. UL 33 – Heat Responsive Links for Fire-Protection Service
- J. UL 555 – Standard for Safety: Fire Dampers
- K. UL 555S – Standard for safety leakage characteristics for dampers in engineered smoke control systems

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01 and 23, Common Work Results for HVAC.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include rated capacities, outlet velocities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 2. Material thickness and finishes, including color charts
 - 3. Dampers, including housings, linkages, and operators.
 - 4. Controllers and other controls.
 - 5. Special fittings
 - 6. Manual-volume damper installations
 - 7. Motorized-control damper installations
 - 8. Fire-damper, smoke-damper, and combination fire and smoke damper installations, including sleeves and duct-mounting access doors.
 - 9. Wiring Diagrams: Power, signal, and control wiring.
 - 10. Copies of UL Installation Instructions.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring Diagrams: Power, signal, and control wiring.
- E. Design Calculation: Calculate requirements for seismic restraints.
- F. All fan motors shall be non-overloading and selected per the discretion of the Engineer.
- G. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
- H. Field quality-control test reports.

- I. Operation and Maintenance Data: To include in emergency, operation, and maintenance manuals.
- J. Structural steel fabrication and installer shall be responsible for the coordination of all framed openings in roof with approved equipment manufacturers. (Openings such as, but not limited to mechanical units, exhaust fans, curb mounted equipment, roof drains, skylights, stair openings, roof hatches, duct through roof penetrations, expansion joints, etc.) Exact sizes and exact locations of openings are to be verified with the approved shop drawings issued for the installation. The exact sizes shall be coordinated prior to any fabrication and installation by any/all trades. Sizes and locations indicated on Contract Drawings are diagrammatic and for information only. Any fabrication and/or installation which has not been properly coordinated with approved equipment manufacturer and must be repaired, relocated, altered, replaced, re-installed or modified in any manner will be done to the satisfaction of the Owner with no additional cost to the Owner or design professional.
- K. Submit the Installation, Operation and Maintenance Manual (IOM) and install thereto.
- L. Provide shop drawings for the following:
 - 1. Volume dampers
 - 2. Flexible duct connections
 - 3. Duct access doors
 - 4. Duct test holes
- M. Submit air pressure drop calculations for each smoke damper and combination fire/smoke damper. Calculations shall include system effects due to elbows, air velocities, non-optimal straight duct lengths, transitions, obstructions and other applicable effects fore/aft of each device. Dampers shall be enlarged in size and transitions be provided as required to system effects in order to provide the actual air pressure drops at 1800 FPM as tested and measured in the factory. The maximum pressure drop shall be 0.25" wg.

1.5 COORDINATION

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.
- B. Coordinate size and location of structural-steel support members.
- C. Coordinate installation of ductwork accessories with actual location.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 90A, 92A, 92B and 101 and all applicable building codes.

1.7 DELIVERY, STORAGE, PROTECTION AND HANDLING

- A. Deliver. Store, store, protect and handle fans and accessories according to Div. 01 and 23 requirements, comply with manufacturer's instructions.
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation
- C. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual
- D. Handling: Handle and lift ductwork accessories in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.
- E. Protect motors, shafts, and bearings from weather and construction dust. Provide sealed housings to prevent debris from entering assembly. Store units off-site until surfaces are ready for immediate installation.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10% of amount installed.

1.9 WARRANTY

- A. One year warranty on parts and labor from date of final acceptance.

1.10 MAINTENANCE MANUALS

- A. Submit and refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures.

PART 2 - PRODUCTS

- 2.1 Manufacturers are listed for a quality assurance level only. Although a manufacturer is listed does not constitute compliance with the specification size, weight, functionality, capacity, noise, or performance levels. It is this contractor's responsibility to assure the proposed manufacturer has complete compliance with the Contract Documents, **prior to bidding**.
 - A. All ductwork and ductwork accessories in or near the pool area (connected to PDU-1, ERU-3, RTU-2, OREF-1) shall be all aluminum construction.

- B. All ductwork connected to EF-1 shall be high density polyethylene (HDPE) blue duct (No Substitutions).

2.2 ACCEPTABLE MANUFACTURERS – VOLUME CONTROL AND SHUT OFF DAMPERS

- A. Ruskin
- B. Louvers and Dampers
- C. Greenheck

2.3 VOLUME CONTROL AND SHUT OFF DAMPERS

- A. Control Dampers: AMCA Standard 500-D tested and rated. Provide dampers with parallel blades for 2-position control, or opposed blades for modulating control. Construct blades of 16 gauge steel; provide heavy-duty molded self-lubricating nylon bearings, 1/2 inch hex steel axles spaced on 9" centers. Construct frame of 5 inch x 1 inch x 16 gauge steel channel with linkage concealed within the jamb. Finish is to be galvanized. For dampers located in ductwork with air velocities greater than 1500 FPM, dampers shall have airfoil blades. Provide frames to accept Ductmate joints where applicable transverse joints are provided. Provide a 2" standoff bracket and locking quadrant manual operator. Dampers for moisture laden airstreams or corrosive environments shall be type 304 stainless steel construction including bearings. Provide sleeve and security bars where required.
- B. Provide positive-locking air volume damper. Provide quadrant (damper handle) which has a spring-loaded locking mechanism which ensures that the handle's position remains locked where it is set. A wingnut lockdown is not acceptable. Field assembled damper hardware into duct and fittings. Snap-In Bearings into 3 inch holes on each side of the duct or fitting, holding the round continuous-rod damper blade in position and passing the rod through the pre-stamped channel in the blade and the bearings. Dampers handle on the outside of the fitting or duct. Damper adjustments can be made by hand—without the need for any tool. The Positive-Locking Air Volume Damper consists of a locking damper handle (or quadrant), two 3 inch bearings, a rod and a round damper blade. All the components shall adhere to the relevant UL requirements, Plenum ratings and SMACNA standards for manual dampers; and are in compliance with NFPA 90A & 90B Standard for the Installation of Air-Conditioning and Ventilating Systems. All non-metallic components are made of flame retardant polymer with a flame rating of 5VA as specified in UL 1995 Standards Code for Heating & Cooling. The positive locking damper handle consists of a bracket, a handle, a thumb trigger, a spring and a retaining ring. The bracket is made of cold rolled steel in conformance with ASTM A1008, 18 gauge nominal thickness 0.0478, tolerance range 0.0438–0.0518. The Handle & Thumb Trigger is made of Polyamide 66 (PA66), flame retardant, glass-reinforced polymer in conformance with CSA-C22.2 No. 238 UL 1995. Stainless steel 302-OP 0.25 wire Compression Spring, 0.026 free length; 7 inch; ten coils, closed, not ground. Carbon Spring Steel with Zinc Bright Plating Retaining Ring, C-SCALE Rockwell Hardness 47–51, Country of origin: USA. Snap-in Bearings (11 inch) (B Long) for use with inside-insulated, (lined), duct and fittings. B-Longs are recommended for all pressure class applications. B-Snaps are recommended for low or medium pressure systems. Clip-on Bearings snap into a 3 inch hole with an E-Clip securing the bearing from the opposite side. Continuous Rod Damper Blades -

Galvanized ASTM A553 LFO G90, 20 and 22 gauge; designed with additional radial reinforcement throughout the disc which effectively equals the strength of 18 gauge material. Available in 4–16 inch diameter. A 3 inch full length bar fits through the formed channel in the center of each damper blade. Basis of Design: Rossi Positive-Locking Air Volume Damper.

- C. Intake and Relief Air Dampers: Provide dampers with opposed blade except gravity relief air dampers shall be parallel blade. Frames and blades shall be of aluminum construction. Blades shall be of the airfoil design. Axle shall be 1/2 inch hex and fitted into nylon bearings. Provide ball bearings on gravity relief dampers. Blades shall be provided with neoprene end and jamb seals for a tight shut off. Construct frame of 5 inch x 1 inch x .125 minimum wall thickness. Provide frames to accept Ductmate joints where applicable transverse joints are provided.

2.4 ACCEPTABLE MANUFACTURERS – AIR TURNING VANES

- A. Aero Dyne HEP as Basis of Design

2.5 AIR TURNING VANES

- A. Multi-blade device with 3" radius blades aligned on 2.4" centers; steel or aluminum construction with set and lockable blades, mounting straps. Performance shall be 0.027" wg pressure drop at 1000 FPM air velocity; 0.105" wg static pressure drop at 2000 FPM air velocity and 0.24" wg static pressure drop at maximum air velocity of 3000 FPM.

2.6 ACCEPTABLE MANUFACTURERS – FLEXIBLE DUCT CONNECTIONS

- A. Ventfabrics (Basis of Design)

2.7 FLEXIBLE DUCT CONNECTIONS

- A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Metal-Edged Connectors: Factory fabricated with a fabric strip 6" wide attached to two strips of 3" wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum or stainless steel sheets. Select metal compatible with ducts.
- C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene. Model Ventglas.
 - 1. Minimum Weight: 30 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 20 to plus 200 degrees F.
 - 4. Service Pressure: Rated to +/- 10" wg.

- D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and Ozone. Model Ventlon.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus to plus 275 degrees F.
 - 4. Service Pressure: Rated to +/- 10" wg.
- E. High-Temperature System, Flexible Connectors: glass fabric coated with silicone rubber. Model Ventsil.
 - 1. Minimum Weight: 16 oz./sq. yd.
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 25 to plus 500 degrees F.
 - 4. Service Pressure: Rated to +/- 8" wg.
- F. High-Corrosive Environment System, Flexible Connectors: Glass fabric with chemical resistant coating. Model Ventel.
 - 1. Minimum Weight: 14 oz./sq. yd.
 - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 degrees F.
 - 4. Service Pressure: Rated to +/- 8" wg.

2.8 ACCEPTABLE MANUFACTURERS – DUCT ACCESS DOORS

- A. Duro Dyne
- B. Ruskin
- C. Ductmate
- D. Air Balance

2.9 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.

- F. Access doors with sheet metal screw fasteners are not acceptable.
- G. The access openings shall not reduce the fire-resistance rating of the assembly. Access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inch in height reading: SMOKE DAMPER or FIRE DAMPER.

2.10 DUCT TEST HOLES

- A. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings with screw cap. Provide extended neck fittings to clear 2" insulation thickness.
- B. Manufacturer – Ventlok 699-2

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Inspect areas to receive dampers. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the dampers. Do not proceed with installation until unsatisfactory conditions are corrected.
- C. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and branch ducts and as required for air balancing; whether indicated on the contract drawings or not.
- D. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations required whether indicated on the contract drawings or not, where ducts and outlets pass through fire, smoke and fire/smoke rated components. Include locations as required by code authorities to isolate the air handling equipment. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges. Install per UL and NFPA requirements.
- E. Locate normal/alarm remote test indicating panels on adjacent walls for duct smoke detectors; mount 48" AFF level with light switches.
- F. For fire and combination fire/smoke dampers; install PVC cleats on the Ductmate type joints; do not install the corner clip bolts. Use slip joints for dampers provided without Ductmate joints. For round and oval ductwork connecting to fire dampers, use galvanized slip joints.
- G. Install fire, smoke and combination fire/smoke dampers per the manufacturer's UL approved installation instructions. Provide a frame system in the wall to support the sleeve; construct according to the manufacturer's installation instructions and per code requirements. Installations shall be approved by the local code bodies having jurisdiction. Install dampers square and free from racking with blades running horizontally. Do not compress or stretch damper frame into

duct or opening. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

- H. All fire, smoke, combination fire/smoke dampers and ceiling dampers shall be operated and tested by Contractor prior to occupancy of a building to determine that they function properly in accordance with NFPA 90A. Provide a compliance report to Engineer and Owner for approval a minimum of 14 days prior to final project closeout.
- I. Provide minimum 3 equivalent straight duct diameters upstream and downstream of smoke and combination fire/smoke dampers. If more space is available, then use the maximum allowable straight duct lengths.
- J. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- K. Provide duct access doors for inspection and cleaning at filters, coils, fans, automatic dampers, fire dampers, combination fire/smoke dampers, smoke dampers, duct smoke detectors and elsewhere as indicated. Provide minimum 18 x 18 inch size unless duct size will not allow; else use maximum available size. Provide duct access doors for steam grid humidifiers.
- L. Provide duct test holes in the supply and return main ducts in straight sections near air handling units before branch take-offs. In addition, provide test holes in exhaust ducts at exhaust fans. Use judgement in locating test holes to improve CFM readings. Locate test holes a maximum of 9 inches on center. Indicate locations on ductwork shop drawings. Test holes shall clear insulation.
- M. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- N. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts. Dampers for moisture laden airstreams or corrosive environments shall be type 304 stainless steel construction including bearings.
- O. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- P. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes, and equipment.
 - 3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 5. On sides of ducts where adequate clearance is available.

- Q. Install the following sizes for duct-mounting, rectangular access doors:
1. One-Hand or Inspection Access: 8 by 5 inches
 2. Two-Hand Access: 12 by 6 inches
 3. Head and Hand Access: 18 by 10 inches
 4. Head and Shoulders Access: 21 by 14 inches
 5. Body Access: 25 by 14 inches
 6. Body Plus Ladder Access: 25 by 17 inches
- R. Install the following sizes for duct-mounting, round access doors:
1. One-Hand or Inspection Access: 8 inches in diameter
 2. Two-Hand Access: 10 inches in diameter
 3. Head and Hand Access: 12 inches in diameter
 4. Head and Shoulders Access: 18 inches in diameter
 5. Body Access: 24 inches in diameter
- S. Install the following sizes for duct-mounting, pressure relief access doors:
1. One-Hand or Inspection Access: 7 inches in diameter
 2. Two-Hand Access: 10 inches in diameter
 3. Head and Hand Access: 13 inches in diameter
 4. Head and Shoulders Access: 19 inches in diameter
- T. Label access doors according to Division 23 Section "Identification for HVAC."
- U. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- V. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings or other general building construction.
- W. Install dampers square and free from racking.
- X. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
- Y. Do not compress or stretch the damper frame into the duct or opening.
- Z. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
- AA. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.
- BB. Install connections to electric, actuators as specified in Division 23.

- CC. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
- DD. Primary elements shall be installed in strict accordance with the manufacturer's published requirements, and with ASME guidelines effecting non-standard approach condition. These elements serve as the primary signals for the airflow systems; therefore; it shall be the responsibility of the Contractor to verify and install, to assure that accurate primary signals are obtained.
- EE. Coordinate with other work, including ductwork, electrical, mechanical, and automatic temperature controls, as necessary to interface the installation of the airflow control systems with other work.
- FF. Provide an identification label to be placed on each unit casing listing model number, size, area, and specified airflow capacity.
- GG. Provide an identification label to be placed on each primary flow element showing airflow direction and listing the model number, system served, size and identifying tag number.
- HH. Provide an identification label to be placed on each airflow indicating transducer listing the model number flow elements served, full scale value, and identifying tag number.

3.2 START UP SERVICE AND GUARANTEE

- A. Provide Factory Authorized startup service. A factory certified representative shall visit the job site after the successful contractor completes installation. The startup service will require inspection of each device; placement location, wiring and operation. A written report of the findings from the start up service shall be provided to the mechanical engineer for review and approval.
- B. Upon approval by the mechanical engineer, each device shall be provided with a 12 month "on-site" warranty for defective equipment and shall also be provided with a standard limited parts warranty for a total of 36-month coverage from date of shipment.

3.3 FIELD QUALITY CONTROL

- A. Provide factory authorized personnel to field quality control. The factory personnel shall assist the Commissioning Agent in the Commissioning process in his work for this equipment.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that the installation complies with the manufacturer's instruction and provides a workable system for the owner, installed per the design intent and that is code compliant to authorities having jurisdiction.
 - 2. Verify that unit is secure on mountings and supporting devices and that connection to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.

4. Adjust damper linkages for proper damper operation.
 5. Verify lubrication for bearings and other moving parts.
 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 8. Shut unit down and reconnect automatic temperature-control operators.
 9. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Provide factory authorized personnel to provide adjustment. The factory personnel shall assist the Commissioning Agent in the Commissioning process in his work for this equipment.
- E. Adjust damper linkages for proper damper operation.
- F. Adjust belt tension.
- G. Refer to Division 23 Section "Testing, Adjusting, and Balance for HVAC" for testing, adjusting, and balancing procedures.
- H. Replace fan and motor pulleys as required to achieve design airflow.
- I. Lubricate bearings.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide factory authorized personnel to initial start-up, check out and shut-down. The factory personnel shall assist the Commissioning Agent in the Commissioning process in his work for this equipment.
- B. Prior to startup, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections and complete pre-startup checklists. Report results in writing.
1. Operational Test: After electrical circuitry has been energized, engage a factory-authorized service representative to start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. The FMCS vendor shall provide programming of the unit for optimum start/stop, morning cool-down cycle, morning warm-up cycle, timed override, date (daily, weekly, monthly, holiday, etc) occupied and unoccupied periods as well as all programming required for the sequence of operation.

3.5 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain rooftop units.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals. Refer to Division 01 and Division 23.
- B. Schedule training with Owner, through Architect, with at least seven days advance notice.

END OF SECTION 23 33 10

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Diffusers
- B. Registers/grilles
- C. Goosenecks

1.2 RELATED WORK

- A. Division 23 – Scope of Work
- B. Division 23 – Common Work Results for HVAC

1.3 REFERENCES

- A. ADC 1062 – Certification, Rating and Test Manual
- B. AMCA 500 – Test Method for Louvers, Dampers and Shutters
- C. ANSI/NFPA 90A – Installation of Air Conditioning and Ventilating Systems
- D. ARI 650 – Air Outlets and Inlets
- E. ASHRAE 70 – Method of Testing for Rating and the Air Flow Performance of Outlets and Inlets.
- F. SMACNA –Duct Construction Standards

1.4 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 01 and 23, Common Work Results for HVAC.
- B. Submit dimensional information on roof hoods along with performance data.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.
- E. Submit a sample of each diffuser, grille, and register type for approval.

1.7 CEILING COORDINATION

- A. Coordinate all ceiling diffuser/grille mounting systems with the ceiling type listed on the architectural drawing. Use drop face diffusers where drop face tiles are used.

1.8 COLOR COORDINATION

- A. Coordinate all diffusers/grilles with Architectural and Mechanical Requirements as indicated on the drawings. Where diffusers are field painted, and then provide factory prime finish.

PART 2 - PRODUCTS

ALL AIR OUTLETS (DRG'S) IN OR NEAR THE POOL AREA (CONNECTED TO PDU-1, ERU-3, RTU-2, OR EF-2) SHALL BE ALL ALUMINUM CONSTRUCTION.

2.1 ACCEPTABLE MANUFACTURERS – CEILING DIFFUSERS

- A. Anemostat
- B. Titus
- C. Tuttle and Bailey
- D. Price

2.2 CEILING DIFFUSERS – LOUVERED FACE TYPE

- A. Four (4) way discharge, horizontal air pattern, throw reducing vanes. Refer to schedule for panel size, neck size, CFM, throw, flex duct runout size, etc. Provide insulated plenum with round stub for ductwork attachment.

- B. Provide diffuser insulation kit to be applied to the back of the diffuser.
- C. Factory fabricated of stamped steel cones with factory baked enamel or powder coated white finish.
- D. Anemostat, SDP w/TRV (Basis of Design) or reviewed equivalent.

2.3 ACCEPTABLE MANUFACTURERS – GRILLES/REGISTERS

- A. Anemostat
- B. Titus
- C. Tuttle & Bailey
- D. Price

2.4 RETURN, RELIEF AND EXHAUST GRILLES

- A. 1/2" x 1/2" x 1/2" aluminum core, aluminum frame, with aluminum opposed blade balancing damper.
- B. Fabricate frame with countersunk screw mounting.
- C. Anemostat GC5 as Basis of Design

2.5 GOOSENECKS

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards of minimum 18 gage galvanized steel.
- B. Mount on minimum 18 inch high curb. The curb assembly shall be double shell; galvanized, insulated, with 2 x 4 inch treated wood nailer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturers' instruction. Coordinate locations with other trades.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

- C. Install diffusers to ductwork with airtight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black.
- F. All air outlets and inlets shall be covered, protected and sealed against contaminant migration into the ductwork at time of installation. Plastic to be removed upon startup. Maintain integrity of protection between the two periods.
- G. Coordinate wall and roof openings with General Contractor.

END OF SECTION 23 37 00

SECTION 26 05 00 - COMMON WORK RESULTS - ELECTRICAL

PART 1 - GENERAL

1.1 EXECUTION OF THE WORK

- A. These specifications call out certain duties of the Electrical Contractor and his Subcontractors. They are not intended as a material list of items required by the Contract. Any reference in these specifications and on the accompanying drawings to the Contractor, Electrical Contractor, Electrical Subcontractor or abbreviation "E.C.", shall be construed to mean the Contractor responsible for all electrical construction (Division 26) work for this project.
- B. This division of the specifications covers the electrical systems of the project. It includes work performed by the electrical trades as well as trades not normally considered as electrical trades.
- C. Provide all items and work indicated on the Drawings and all items and work called for in this division of the specifications in accordance with the conditions of Contract (Division 01 General Requirements Documents). This includes all incidentals, equipment, appliances services, hoisting, scaffolding, supports, tools supervision, labor consumable items, fees licenses, etc., necessary to provide complete systems. Perform start-up and checkout on each item and system to provide fully operable systems.
- D. Comply with all provisions of the Contract Documents including the General Conditions, and Division 01 General Requirements of the specifications.
- E. Certain terms such as "shall, provide, install, complete, start-up" are not used in some parts of these specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.
- F. Examine and compare the Electrical Drawings with these specifications, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid the most stringent requirements must be included in said bid.
- G. Examine and compare the Electrical Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid.
- H. Install and coordinate the electrical work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.
- I. It is the intent of the Drawings and Specifications to provide a complete workable system ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform with the intent, are to be considered a part of the Contract.

- J. These specifications are basically equipment, installation, and performance Specifications. Some installation details are indicated on the Drawings. Where these differ from the Specifications, apply the more stringent at time of bid. Upon award of bid, contact Architect/Engineer for definite instructions.
- K. All materials furnished by the Contractor shall be new and unused (temporary lighting and power products are excluded) and free from defects. All materials used shall bear the Underwriter's Laboratory, Inc. label provided a standard has been established for the material in question.
- L. All products and materials shall be new, clean, free of defects and free of damage and corrosion.
- M. The exclusion from, or limitation in, the symbolism used on the Drawings, or the language used in the Specifications for electrical work shall not be interpreted as a reason for omitting the accessories necessary to complete any required system or item of equipment.
- N. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.
- O. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material shall be the product of one manufacturer throughout. Multiple manufacturers will not be permitted.
- P. Receive, inspect, store, install and wire Owner-furnished equipment where Owner furnished equipment is supplied.
- Q. Painting
 - 1. All manufactured electrical equipment such as switchgear, control equipment, lighting fixtures, etc., shall have factory-applied finish as specified in the appropriate article in the Electrical Parts of the Specification.
 - 2. All other uncoated steel items such as boxes supports, hanger, rods, etc., shall be galvanized or have a shop coat of paint applied under this part of the Specification. Normally shop coats shall be an approved primer containing at least 50 percent rust inhibitive pigment, applied before assembling the different parts.
 - 3. Including painting and retouching of:
 - a. Pre-finished enclosures of switchgear, panelboards, switches, wireways, where the finish has been slightly damaged in transit before assembling the different parts.
 - b. Any woodwork furnished in the electrical work.
 - c. Fixture hangers, except those received from manufacturers that are prefinished.
 - d. Miscellaneous iron brackets and supports.
 - e. Steel conduits buried in earth.
 - 4. Woodwork installed under this part of the specification shall be finished with filler sealer plus two (2) coats of PPG "Water Spar" gloss varnish.

1.2 COORDINATION OF THE WORK

- A. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.
- B. Carefully check space requirements with other trades and the physical confines of the area to ensure that all material can be installed in the spaces allotted thereto including finished suspended ceilings and the spaces within the existing building. Make modifications thereto as required and approved.
- C. No items foreign to the electrical system shall be run in the dedicated space of the electrical equipment. Dedicated space shall be defined as the width and depth of the equipment from the floor to the bottom of the structural ceiling. Foreign systems include but are not limited to ductwork, piping, sprinklers, drip trays, etc. Contractor shall be responsible to coordinate the locations of the dedicated spaces with all trades as required.
- D. Transmit to other trades all information required for work to be provided under their respective Sections in ample time for installation.
- E. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.
- F. Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate, project and schedule work with other trades in accordance with the construction sequence.
- G. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- H. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations approved by the Architect/Engineer before proceeding with the installation.
- I. The Drawings show only the general run of raceways and approximate location of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made. All such modifications shall be made without additional cost to the Owner.
- J. Obtain from the Architect/Engineer in the field, the location of such outlets or equipment not definitively located on the Drawings.
- K. Circuit "tags" in the form of arrows are used where shown to indicate the home runs of raceways to electrical distribution points. These tags show the circuits in each home run and the panel designation. Show the actual circuits numbers on the finished record drawing and on

panel directory card. Where circuiting is not indicated, Electrical Contractor must provide required circuiting in accordance with the loading indicated on the drawings and/or as directed.

- L. The Drawings generally do not indicate the exact number wires in each conduit for the branch circuit wiring of fixtures, and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated and control, wiring diagrams, if any, specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.
- M. Adjust location of conduits, panels, equipment, pull boxes, fixtures, etc. to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each raceway prior to fabrication.
 - 1. Right-of-Way:
 - a. Lines which pitch have the right-of-way over those which do not pitch. For example: steam, condensate, and plumbing drains normally have right-of way. Lines whose elevations cannot be changed to have right-of-way over lines whose elevations can be changed.
 - b. Make offsets, transitions and changes in direction in raceways as required to maintain proper headroom in pitch of sloping lines whether or not indicated on the Drawings.
- N. Wherever the work is of sufficient complexity, prepare additional Detail Drawings to scale similar to that of the bidding Drawings, prepared on tracing medium of the same size as Contract Drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit for review Drawings clearly showing the work and its relation to the work of other trades before commencing shop fabrication or erection in the field.
- O. Contractor shall furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate his work with the work of other trades. No work shall be installed before coordinating with other trades.
- P. Coordinate with contractors for work under other Divisions of this specification for all work necessary to accomplish this contractor's work.
- Q. Where electrical connections are required, to equipment provided by the Owner or by other trades, this Contractor shall verify the exact requirements for these connections prior to ordering any materials or laying out any work. Where there is a discrepancy between the equipment being furnished and that shown on the Contract Drawings, the Contractor shall notify the Architect/Engineer for direction. Failure to comply with this coordination shall not constitute a reason for extra monies for equipment ordered or installed. Restocking charges will not be paid.

1.3 EXAMINATION OF SITE

- A. Prior to the submitting of bids, the Contractor shall visit the site of the job and shall familiarize himself with all conditions affecting the proposed installation and shall make provisions as to

the cost thereof. Failure to comply with the intent of this paragraph will in no way relieve the contractor of performing all necessary work shown on the Drawings.

1.4 PROGRESS OF WORK

- A. The Contractor shall order the progress of his work so as to conform to the progress of the work of other trades and shall complete the entire installation as soon as the conditions of the building will permit. Any cost resulting from the defective or ill-timed work performed under this section shall be borne by the Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair. Any such repairs shall be subject to review and acceptance of the Architect/Engineer.
- B. Delivery of Materials: Deliver materials in manufacturer's unopened container fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- C. Storage of Materials, Equipment and Fixtures: Store materials suitably sheltered from the elements, but readily accessibly for inspection by the Architect/Engineer until installed. Store all items, susceptible to moisture damage, in dry, heated spaces.

1.6 HOUSEKEEPING PADS AND ANCHOR BOLTS

- A. Housekeeping pads for all floor mounted equipment shall be furnished by the General Contractor. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 4" clear around the equipment and supports. Pads shall be a minimum of 4" high and made of a minimum 28 day, 2500 psi concrete reinforced with 6" x 6" 6/6 gauge welded wire mesh. Tops and sides of pad shall be troweled to smooth finishes, equal to those of the floors, with all internal corners bullnosed to 3/4" radius.
- B. Furnish and install galvanized anchor bolts for all equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be the size and number recommended by the Manufacturer of the equipment and shall be located by means of suitable templates.
- C. The Electrical Contractor shall furnish information on pad sizes to the General Contractor in a timely manner for him to proceed with his work. Failure to do so shall constitute a reason for the Electrical Contractor to provide such pads at his own expense.

1.7 EQUIPMENT ACCESSORIES

- A. Provide supports, hangers and auxiliary structural members required for support of the work according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

- B. Furnish and set all sleeves for passage of raceways through structural, masonry and concrete walls or floors and elsewhere as will be required for the proper protection of each raceway passing through building surfaces.
- C. Wall mounted equipment may be directly secured to wall by means of steel bolts. Maintain at least 1" air space between equipment and supporting wall. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels providing a high degree of mounting flexibility, such as those manufactured by Kindorf, Glob-Strutt and Unistrut, may be used for mounting arrays of equipment.

1.8 EXCAVATION, TRENCHING AND BACKFILLING

- A. Provide excavation for the Work. Excavate all material encountered, to the depths indicated on the drawings or required. Remove from the site, excavated materials not required or suitable for backfill as determined by the Soils Engineer. Provide grading, as may be necessary, to prevent surface water from flowing into trenches or other excavations. Remove any water accumulating therein. Provide sheeting and shoring as may be necessary for the protection of the Work and for the safety of personnel.
- B. Provide trenches of widths necessary for the proper execution of the Work. Grade bottom of the trenches accurately to provide uniform bearing and support the Work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four (4") inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose granular, moist earth, thoroughly machine tamped, to a compaction level of at least 92 maximum density as per ASTM D-1557 Modified Proctor Method. Whenever unstable soil that is incapable of properly supporting the Work, as determined by Soils Engineer, is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel, or other suitable material acceptable to the Soils Engineer.
- C. Excavate trenches for utilities to a depth that will provide 24-inch minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown.
- D. Trenches should not be placed within ten (10) feet of foundation or soil surfaces which must resist horizontal forces.
- E. Do not backfill trenches until all required tests have been performed and the installation observed by the Soils Engineer. Comply with the requirements of other sections of these specifications. Backfill should consist of non-expansive soil with limited porosity. Deposit in eight (8") inch layers and thoroughly and carefully compact to 92% maximum density as per ASTM D-1557 Modified Proctor Method. Uniformly grade the finished surface.
- F. The Contractor shall have and pay for the services of a qualified Soils Engineer approved by the Architect. Soils Engineer to submit test reports to the Architect.

1.9 PROTECTING TRENCHES

- A. Provide suitable barriers and warning tapes around all trenches to prevent accidental stepping or driving into them. Where left open overnight, provide warning lights in addition to tape barriers.
- B. Remove water from trenches on a daily basis, weather permitting.

1.10 CUTTING, PATCHING

- A. The work shall be carefully laid out in advance. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of raceway, outlets or other equipment, the work shall be carefully done. Any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc. shall be repaired by skilled mechanics or the trades involved at no additional cost to the Owner.
- B. The Contractor shall do no cutting, channeling, chasing or drilling of unfinished masonry, tile, etc., unless he first obtains permission from the Architect/Engineer. If permission is granted, the Contractor shall perform this work in a manner approved by the Architect/Engineer
- C. Where conduits, mounting channels, outlet, junction, or pull boxes are mounted on a painted surface, or a surface to be painted, they shall be painted to match the surface. Whenever support channels are cut, the bare metal shall be cold galvanized.
- D. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. The trade requiring them to properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.
- E. Structural steel fabricator and installer shall be responsible for the coordination of all framed openings in roof with approved equipment manufacturers. (Openings such as, but not limited to mechanical units, exhaust fans, curb mounted equipment, roof drains, skylights, stair openings, roof hatches, smoke hatches, duct thru roof penetrations, expansion joints, etc.)

Exact sizes and exact locations of all openings are to be verified with the approved shop drawings issued for the installation. The exact sizes shall be coordinated prior to any fabrication and installation by any/all trades. (Sizes and locations indicated on contract drawings are diagrammatic and for information only.)

Any fabrication and/or installation which has not been properly coordinated with approved equipment manufacturer and must be repaired, relocated, altered, replaced, re-installed or modified in any manner will be done to the satisfaction of the Owner with no additional cost to the Owner or design professional.

1.11 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire resistance of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping".

1.12 NORMAL VOLTAGES (Unless Otherwise Noted)

- A. Primary Distribution – above 480 volts or 208 volts.
- B. Secondary Distribution – 120/208 volt, 3 phase 4 wire.

1.13 MOUNTING HEIGHTS

- A. Unless otherwise noted or required because of special conditions, locate outlets as follows:
 - 1. Heights listed are from finished floor to center of device. Verify exact locations with the Architect/Engineer before installation.
 - a. Convenience and Signal Outlets, Telephone and Data: 18 inches, unless otherwise noted.
 - b. Lighting Switches: 3 feet, 6 inches (42 inches).
 - c. Disconnect Switches and Motor Controller: Five (5) feet.
 - d. Exit Lights: Two (2) inches above top of door to bottom.
 - e. Audio/Visual Fire Alarm Devices: Eighty (80) inches to bottom.
 - f. Fire Alarm Pull Stations: Forty-Two (42) inches.

1.14 DEMOLITION AND CONTINUANCE OF EXISTING SERVICES – REFER TO SECTION 26 07 00

- A. All existing electrical services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Should any existing services, etc., interfere with new construction, the Contractor shall (after obtaining written approval from the Architect/Engineer) alter or reroute such existing equipment to facilitate new construction.
- C. Under no circumstances shall existing services, etc., be terminated or altered unless deemed necessary by the Architect/Engineer or specified herein; also, prior to altering any existing situation, the Contractor shall notify the Owner in writing giving two (2) weeks advance notice of planned alteration.
- D. It shall be solely the Contractor's responsibility to guarantee continuity of present facilities (with respect to damage or alteration due to new construction) and any unauthorized alteration to existing equipment shall be corrected by the Contractor to the Architect/Engineer's satisfaction at the Contractor's expense.

1.15 CLEANING UP

- A. Contractor shall take care to avoid accumulation of debris, boxes, crates, etc., resulting from the installation of his work. Contractor shall remove from the premises each day all debris, boxes, etc., and keep the premises clean, subject to the Architect/Engineer's instructions, which shall be promptly carried out.

- B. Contractor shall clean all fixtures and equipment at the completion of the project.
- C. All switchboards, panelboards, wireways, trench ducts, cabinets, enclosures, etc. shall be thoroughly vacuumed clean prior to energizing equipment and at the completion of the project. Equipment shall be opened for observation by the Architect/Engineer as required.

1.16 WATERPROOFING

- A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, perform it prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect/Engineer and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
- B. If Contractor penetrates any walls or surfaces after they have been waterproofed, he shall restore the waterproof integrity of that surface as directed by the Architect/Engineer at his own expense, using workmen skilled in that trade.

1.17 PROHIBITED LABELS AND IDENTIFICATIONS

- A. Prohibited Markings: In all public areas, tenant areas and similar locations within the project, the inclusion or installation of any item, element or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited. Also prohibited is the inclusion or installation of any article which bears visible evidence that an insignia, name, label, or other device had been removed.
- B. Exception: Required Underwriter's Laboratory labels shall not be removed nor shall identification specifically required under the various technical sections of the specifications be removed.

1.18 CONNECTION TO EXISTING UTILITIES AND SYSTEMS

- A. When connecting to an existing system, the Electrical Contractor shall be responsible to verify the integrity of the system being connected to. All applicable testing and acceptance will apply.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. If products and materials are specified or indicated on the Drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of Shop Drawings where Shop Drawings are required or as approved in writing where Shop Drawings are not required.

- B. All equipment capacities, etc. are listed for job site operating conditions. All equipment sensitive to altitudes or ambient temperatures shall be derated and method of derating shown on Shop Drawings. Where operating conditions shown differ from the laboratory test conditions, the equipment shall be derated and the method of derating shown on Shop Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Architect/Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special supports, connections, wiring, accessories, etc.
- B. Use mechanics skilled in their trade for all work.
- C. Keep all items protected before and after installation. Clean up all debris.
- D. Perform all tests required by local authorities in addition to tests specified herein, such as life safety systems.
- E. Applicable equipment and materials to be listed by Underwriters' Laboratories and Manufactured in accordance with ASME, NEMA, ANSI or IEEE standards, and as approved by local authorities having jurisdiction as mentioned in Division 1.
- F. Before commencing Work, examine all adjoining, underlying. Work on which this Work is in any way dependent for perfect workmanship and report any condition which prevents performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

3.2 PREMIUM TIME WORK

- A. The following Work shall be performed at night or weekend other than holiday weekends as directed and coordinated with the Owner.
 - 1. All tie-in, cut-over and modifications to the existing electrical system and other existing system requiring tie-ins or modifications shall be arranged and scheduled with the Owner to be done at a time as to maintain continuity of the service and not interfere with normal building operations.

3.3 PROJECT MANAGEMENT AND COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specification to ensure efficient and orderly installation of each part of the work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule
 2. Preparation of the Schedule of Values
 3. Installation and removal of temporary facilities and controls
 4. Delivery and processing of submittals
 5. Progress meetings
 6. Pre-installation conferences
 7. Project closeout activities
 8. Startup and adjustment of systems
 9. Project closeout activities
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into the work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

3.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

- a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequence.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Submit electronic copies of each submittal. Architect/Engineer, through Construction Manager, will review, mark up and return.
 - a. Submit electronic copy where Coordination Drawings are required for operation and maintenance manuals.
 3. Refer to individual Sections for Coordination Drawing requirements for work in those Sections.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

3.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project Superintendent, provide other administrative and supervisory personnel as required for proper performance of the work.

3.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project Site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later

than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Procedures for processing field decisions and Change Orders
 - e. Procedures for requests for interpretations (RFIs)
 - f. Procedures for testing and inspecting
 - g. Procedures for processing Applications for Payment
 - h. Submittal procedures
 - i. Preparation of Record Documents
 - j. Use of the premises and existing building
 - k. Work restrictions
 - l. Owner's occupancy requirements
 - m. Responsibility for temporary facilities and controls
 - n. Construction waste management and recycling
 - o. Parking availability
 - p. Office, work, and storage areas
 - q. Equipment deliveries and priorities
 - r. First aid
 - s. Security
 - t. Progress cleaning
 - u. Working hours
 3. Minutes: Record and distribute meeting minutes.
- C. Pre-installation Conferences: Conduct a pre-installation conference at Project Site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents
 - b. Deliveries
 - c. Review of mockups
 - d. Possible conflicts
 - e. Time schedules
 - f. Manufacturer's written recommendations

- g. Acceptability of substrates
 - h. Temporary facilities and controls
 - i. Coordination with other work
 - j. Protection of construction and personnel
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.
- 1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements
 - 2) Status of submittals
 - 3) Off-site fabrication
 - 4) Site utilization
 - 5) Hazards and risks
 - 6) Progress cleaning
 - 7) Status of correction of deficient items
 - 8) Requests for interpretations (RFIs)
 - 9) Status of proposal requests
 - 10) Pending changes
 - 11) Status of Change Orders
 - 12) Pending claims and disputes
 - 13) Documentation of information for payment requests

3. Minutes: Record the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

END OF SECTION 26 05 00

SECTION 26 05 01 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the Work included in accordance with the Contract Documents.
- B. Provide all labor, materials, equipment, tools, appliances, auxiliaries, services, hoisting, scaffolding, support, supervision, and Project Record Documents, and perform all operations for the furnishing and installing of the complete electrical system, including but not limited to the work described hereinafter. The work shall meet or exceed the latest codes, regulations and requirements required by the local Building Department (as mentioned in Division 01).
- C. The electrical work is shown schematically on the Drawings to indicate the general system arrangement and configuration. The work of this Division shall include coordination with the work of other Divisions of the Specifications and the Contract Documents so as to provide a complete and operational system capable of being readily operated and maintained, including approved re-arrangement of the systems and equipment and re-routing of distribution services to enable the complete system to fit within the confines of the allotted electrical spaces, all to the satisfaction of the Architect/Engineer or as directed by the Architect/Engineer.
- D. The work shall include but not limited to the following:
 - 1. Low voltage switchboard rework
 - 2. Panelboards and panelboard rework
 - 3. Feeder and branch circuits
 - 4. Wiring devices
 - 5. Lighting fixtures
 - 6. Lighting controls
 - 7. Equipment connections

1.2 SETTING OUT OF WORK

- A. Layouts shown for mechanical equipment and elevator machine rooms are for estimating purposes only. Coordinate installation of conduit, outlets, luminaries, and equipment with final room equipment layout as supplied by equipment supplier.
- B. Where switches, receptacles, fire alarm pull stations, are in the same general location, outlets shall be aligned vertically unless otherwise called for by the Architect. Comply with ADA mounting heights.
- C. All equipment capacities, etc. are listed for job site operating conditions. All equipment sensitive to altitudes or ambient temperatures shall be derated and method of derating shown on the Shop Drawings.
- D. Use mechanics skilled in their trade for all work.

- E. Keep all items protected before and after installation. Clean up all debris.
- F. Perform all tests required by local authorities in addition to tests specified herein, such as life safety systems.
- G. Applicable equipment and materials shall be listed by Underwriters' Laboratories and manufactured in accordance with ASME, NEMA, ANSI or IEEE standards and as approved by local authorities having jurisdiction.
- H. Before commencing work, examine all adjoining, underlying, etc., work on which this work is in any way dependent for perfect workmanship and report any condition which prevents performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

1.3 MECHANICAL EQUIPMENT WIRING

- A. Provide all labor and materials required to complete electrical (power) wiring for plumbing, heating and ventilating, elevators, and miscellaneous equipment, as called for in these specifications and/or shown on the Drawings.
- B. Provide all single phase motor protection switches and combination starters and disconnects as required for mechanical equipment unless otherwise specifically noted in these specifications or on the drawings. Remote starters will be provided by the trade providing the motor. Coordinate mechanical/electrical equipment coordination schedule on the drawings.
- C. Confirm final connections, loads, and locations of motors prior to ordering of equipment and rough in installation.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 01

SECTION 26 05 02 - ELECTRICAL ABBREVIATIONS AND DEFINITIONS

PART 1 - GENERAL

1.1 REFERENCES

- A. Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.

1. Abbreviations

a.	NEC	National Electrical Code
b.	OSHA	Occupational Safety and Health Act
c.	ANSI	American National Standards Institute
d.	NFPA	National Fire Protection Association
e.	ASA	American Standards Association
f.	IEEE	Institute of Electrical and Electronics Engineers
g.	NEMA	National Electrical Manufacturers Association
h.	UL	Underwriters' Laboratories, Inc.
i.	IES	Illuminating Engineering Society
j.	IPCEA	International Power Cable Engineers Association
k.	ASTM	American Society of Testing Materials
l.	ETL	Electrical Testing Laboratories, Inc.
m.	EIA	Electronic Industries Association
n.	BIL	Basic Impulse Level
o.	LED	Light Emitting Diode
p.	O.E.M.	Original Equipment Manufacturer
q.	IBC	International Building Code

1.2 DEFINITIONS

- A. "PROVIDE" means to supply, purchase, transport, place, erect, connect, test, and turn over to Owner, complete and ready for regular operation, the particular Work referred to.
- B. "INSTALL" means to join, unite, fasten, link, attach, set up, or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.
- C. "FURNISH" means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular Work referred to.
- D. "WIRING" means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such Work.
- E. "CONDUIT" means the inclusion of all fittings, hangers, supports, sleeves, etc.

- F. "AS DIRECTED" means as directed by the Architect/Engineer, or his representative.
- G. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 02

SECTION 26 05 03 - CODES, FEES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Comply with Codes in accordance with the Contract Documents.

1.2 CODES

- A. The electrical installation shall comply with the National Electrical Code and any other agency or authority having jurisdiction in this area.
- B. All equipment shall be equal to or exceed the minimum requirements of N.E.M.A., I.E.E.E., and UL.
- C. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect/Engineer prior to execution of the Work. The work shall be carried out according to the requirements of such code in accordance with the instruction of the Architect/Engineer and at no additional cost to the Owner.
- D. The provisions of Standards, Codes, Laws, Ordinances, etc., shall be considered minimum requirements. In case of conflict between their published requirements, the Owner's Representative shall determine which is to be followed and his decision shall be binding. Specific requirements of this specification and/or the drawings which exceed the published requirements shall take precedence over them.

1.3 FEES

- A. All local fees and permits and services of inspection authorities shall be obtained and paid for by the Contractor. The Contractor shall cooperate fully with local companies with respect to their services. Contractor shall include in his bid; any costs to be incurred relative to power service (primary and/or secondary) and telephone service.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 03

SECTION 26 05 04 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work under this section is subject to requirements of the contract documents, including the general conditions and supplementary conditions, and sections under Division 01, General Requirements.
- B. During construction, keep an accurate record of all deviations between the work as shown on Drawings and that which is actually installed. Keep this record set of prints at job site for review by the Architect/Engineer.
- C. Upon completion of the installation and acceptance by the Owner, obtain from the Architect a complete set of black and white prints of the original contract drawings. Supplemental drawings, clarification drawings, change order drawings, etc., will not be furnished. Enter thereon, in a neat and accurate manner, a complete record of all revisions to the original Drawings as actually installed. This shall include but not be limited to all information relative to change orders, field directive, clarifications (either in written form or drawings), field modifications, etc. Submit this set of black and white prints to the Architect/Engineer for review. After review by the Architect/Engineer, make necessary changes and then deliver them to the Architect for transmittal to the Owner.
- D. Provide in each main electrical service room a framed copy, under glass, of the appropriate One Line Riser Diagram as reviewed by the electrical engineer. Media shall be a high quality presentation type paper.
- E. Provide location of all underground conduits outside and all feeders (1000 amps or more) on the interior. Show dimensioned location from a wall or column line and the depth.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 04

SECTION 26 05 05 - REVIEW AND ACCEPTANCES

PART 1 - GENERAL

1.1 SUBSTITUTION OF MATERIALS OR EQUIPMENT

- A. Wherever the words "for approval" or "approved" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of apparatus for that specified, submit all information pertinent to the adequacy and adaptability of the proposed apparatus, and secure Architect/Engineer's acceptance before apparatus is ordered.
- B. All requests for substitution of materials or equipment shall be made by the Contractor within thirty (30) days after the execution of the Owner/Contractor Agreement. No requests for substitution will be accepted prior to execution of the Owner/Contractor Agreement or from anyone other than the successful Contractor.
- C. Wherever quantities or a definite make and size of apparatus is specified, the make and size of apparatus which is proposed must conform substantially (in regard to the operating results) to that specified or implied. Same shall apply to important dimensions relating to operation of apparatus in coordination with the rest of the system, or to properly fitting it into available space conditions. Any substitution of equipment or apparatus shall include all necessary revisions, as required to complete the installation.
- D. Acceptance of substitutions, for equipment specified herein, will not be given merely upon submission of manufacturer's names and will be given only after receipt of complete and satisfactory performance data covering the complete range of operating conditions in tabular and graphical form. Furnish complete and satisfactory information relative to equipment dimensions, weight, etc. Acceptance of all equipment specified or shown on the Drawings, or substitutions submitted for that specified or shown on the Drawings, will be granted if such equipment, in the opinion of the Architect/Engineer, conforms to the performance requirements, space conditions, weight requirements and quality requirements. Any additional construction and design costs incurred, as a result of any accepted substitution, shall be borne by this Contractor. The opinion and judgement of the Architect/Engineer shall be final, conclusive, and binding.

1.2 SUBMITTAL LIST

- A. Product Data, Shop Drawings: Bear stamp of approval of authority having jurisdiction and the Owner's insurance underwriter.
- B. Within thirty (30) days after date of execution of the Owner/Contractor Agreement, submit for review and acceptance, a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom this trade proposes to employ.
- C. Any requests for substitutions of equipment or materials must be submitted and returned prior to submitting the Submittal List. Only specified or accepted manufacturers or suppliers shall appear on the Submittal List.

- D. The complete Submittal List must be reviewed and accepted by the Architect/Engineer prior to submittal of Shop Drawings. No Shop Drawings will be processed without an accepted Submittal List.
- E. The Submittal List shall include all material, systems, and equipment as listed herein.

1.3 SHOP DRAWINGS

- A. Within 90 days after date of execution of the Owner/Contractor Agreement, prepare and submit detailed Shop Drawings for materials, systems and equipment as listed herein, in each section of this specification. Should the Contractor fail to submit shop drawings in a timely manner, or fail to order materials in a timely manner, the Contractor shall be required to install temporary materials when deemed necessary to avoid delaying the project. The Contractor shall replace the temporary materials with the specified materials at his/her own cost.
- B. The Work described in any Shop Drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted Shop Drawing shall include a certification that all related job conditions have been checked and that no conflict exists.
- C. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and re-submittal as may be required. All submittals shall be complete and contain all required and detailed information. Re-submittals shall be made within fourteen (14) days of receipt of rejected submittals.
- D. Acceptance of any submitted data or Shop Drawings for material, equipment apparatus, devices, arrangements, and layout shall not relieve Contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details, to efficiently perform the requirements and intent of the Contract. Such acceptance shall not relieve Contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or Shop Drawings.
- E. Each Shop Drawing shall contain job title and reference to the applicable drawing and specification article.
- F. Individual Shop Drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided in other than this manner will be returned without review.
- G. All nameplate data shall be complete at time of equipment submittals – refer to Section 26 05 53 for identification requirements.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

ELECTRICAL SUBMITTAL LIST

DATA:
CONTRACTOR:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>REMARKS</u>
Raceways		
Wire and Cable (480 Volts and Below)		
Switches Receptacles		
Wall Plates		
Grounding System		
Disconnecting Switches		
Fuses		
Panelboards		
Contactors		
Luminaires (each type specified)		
Lamps		
Exit Lights		
Poles & Standards		
Battery Operated Emergency Lights		

NOTE: THIS IS A SAMPLE LIST AND DOES NOT NECESSARILY REFLECT THE EQUIPMENT LIST REQUIRED FOR THIS PROJECT.

END OF SECTION 26 05 05

SECTION 26 05 06 - GUARANTEE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide a Guarantee in accordance with the Contract Documents
- B. Submit a single guarantee stating that all portions of the work are in accordance with Contract requirements. Guarantee all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner; except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies which occur during the guarantee period at no additional cost to the Owner, all to the satisfaction of the Owner and Owner/Engineer. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 06

SECTION 26 05 10 - TESTING, INSPECTION AND CERTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General – The Contractor shall completely test and inspect all systems in accordance with the specifications and drawings. The Contractor shall certify that all systems are in complete working order prior to being turned over to the owner.

1.2 STANDARDS

- A. Except as modified by governing codes and by the contract documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. NFPA
 - 2. NEMA
 - 3. NEC
 - 4. IEEE
 - 5. IPCEA
 - 6. ANSI
 - 7. UL
 - 8. Local Fire Department

1.3 GENERAL TESTING

- A. It shall be the responsibility of this Contractor to furnish all testing equipment and labor necessary to perform the following tests:
 - 1. After wires or cables are in place, but before being connected to devices and equipment, the system shall be tested for shorts, opens, intentional and unintentional grounds. Wires or cables that are shorted or unintentionally grounded shall be replaced.
 - 2. A voltage test shall be made on the last outlet of each branch circuit and the potential drop shall not exceed 2%. Voltage drops for panel and large feeders shall not exceed 3% hence the total voltage drop for a feeder and any branch circuit shall not exceed 5% of the service voltage. The test shall be made under design load or its equal.
 - 3. Any wiring device or electrical apparatus in this contract, if grounded or shorted on an integral "line" part, shall be removed and the trouble corrected.
 - 4. When required, complete test and inspection records shall be made and incorporated into a report for each piece of equipment tested. All readings taken shall be recorded. Four (4) copies shall be submitted to the Engineer for approval.
 - 5. All tests must be conducted in the presence of Project Coordinator.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all testing instruments, equipment and all materials, connections, etc., required to perform tests in accordance with these specifications.

PART 3 - EXECUTION

3.1 WIRING TEST

- A. All wiring and cable tests shall be made before any circuits, main switch, motor, transformer or line is energized.
- B. Tests shall be made for continuity, identification and absence of shorts and grounds for each conductor. Both ends of a given conductor shall be identified alike. Before circuit terminal connections are made, continuity and identification of wiring shall be checked by means of a DC test device using a bell, light, meter, or buzzer.
- C. Insulation test shall be made at the following values:

480Y/277 Volt wiring at 1000 Volts DC
208Y/120 Volt wiring at 500 Volts DC
- D. Insulation resistance between phase conductors and ground shall not be less than the minimum requirements of 2000 meg-ohms.
1. Wire terminations are not to be made to equipment (motors, MCCs, bus ducts, etc.), until that piece of equipment has been tested and verified as specified in this section.
 2. Test motor feeders with motors disconnected, but with circuit breakers, switches or starters in the circuit opened so as to include only that portion of the feeder it is desired to test.
 3. Test lighting feeders with the circuit breakers and panelboards connected but with lighting branch circuit breakers or switches open so as to include only the feeder circuit desired to test.
- E. Contractor shall correct or replace any circuit which is defective or grounded and he shall also correct all other troubles encountered by these tests. All defects whether due to faulty workmanship or material furnished by the Contractor shall be corrected under this section at the Contractor's expense in a manner acceptable to the Engineer.

3.2 LIGHTING TEST

- A. Check all lighting fixtures for proper operation. All Contractor supplied fixtures shall be 100% operable at no additional cost to the Owner. Repair cost to the Owner supplied fixtures shall not be the responsibility of the Contractor unless otherwise stated.

3.3 MOTOR TEST

- A. All 208/120V motors shall be "spot tested" with 500V DC in a similar manner. The minimum resistance to ground shall be 2000 meg-ohm (corrected to 20 degrees C). The Contractor shall record the ambient temperature of the motor and submit this value along with insulation resistance value.
- B. Make the following checks on all motors prior to start-up:
 - 1. Check motor name plates for H.P., speed, phase and voltage. Verify proper wiring.
 - 2. Check shaft for freedom of rotation.
 - 3. Verify that the motor is properly lubricated prior to energizing.
- C. Contractor shall furnish a proper sized heater for each overload relay. Notify the Engineer prior to installation of the motor full-load current rating, the number of overload relays, the starter catalog number, and the heater catalog number. The Engineer will aid in the selection of the proper heaters if requested, provided all pertinent information is given.
- D. Make the following tests on all motors during or immediately after start-up:
 - 1. Check for proper shaft rotation.
 - 2. Check motor for smooth operation (vibration).
 - 3. Take a current reading using a clamp-on ammeter. (No-load readings and loaded readings).
- E. Equipment shall be put into operation after certification by the Contractor that the installation is satisfactory.

3.4 PANELBOARD TESTS

- A. "Spot Test" all equipment to be operated on the 208/120V systems at 500V DC prior to connecting feeders. A minimum insulation resistance of 2000 meg-ohms shall be obtained between all phases and between phase and ground.

3.5 SPOT TEST

- A. "Spot Test" mentioned in this section shall be interpreted as the specific test method of obtaining insulation resistance by applying indicated test voltage for 60 seconds to the equipment or wiring being tested.

3.6 CONTROL WIRING/OUTLET TEST

- A. Control wiring shall perform the function as noted in operation methods and/or included schematics and single line diagrams.
- B. All 120 volt outlets shall be tested with a Daniel Woodhead Cat. No. 1750 and 1760 tester under the supervision of the Coordinator. Minimum acceptable tension is 4 oz. for NEMA 1-15R, and 5-20R, 6-15R, 6-20R, 7-15R, 7-20R, 14-15R, 14-20R, 15-15R and 15-20R.

END OF SECTION 26 05 10

SECTION 26 05 14 - EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide final connections to equipment and coordinate same in accordance with the Contract Documents. <Verify connection requirement with schedule on drawings.>
- B. Equipment to receive final connections shall include but not be limited to the following:
 - 1. Elevators
 - 2. Motors and Equipment
 - 3. Appliances
 - 4. Owner Furnished Equipment
- C. Related work on Division 26
 - 1. Section 26 05 21 – Wire and Cable (0-1000)
 - 2. Section 26 24 19 – Motor Control Center
 - 3. Section 26 29 13 – Enclosed Controllers
- D. Related work specified in other Divisions of these specifications.
 - 1. Vertical Transportation
 - 2. Motors
 - 3. Control Wiring
 - 4. Appliances

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. American National Standard Safety Code for Elevators, Dumbwaiters and Moving Walks (ANSI A17.1).

1.3 QUALITY ASSURANCE

- A. Prior to the submitting of bids, the contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.

- B. Connections shall be made in accordance with the manufacturers' recommendations and approved shop drawings.

1.4 COORDINATION

- A. Prior to ordering breakers, switches, fuses, wire, conduit or any equipment required for connection to equipment supplied by the Owner, this Contractor or other trades, verify the exact current, phase, voltage and frequency of that equipment to assure the proper equipment is provided for said connections. Failure to do so, shall be cause for the Contractor to provide the proper rated equipment at his expense including all labor, material, taxes, freight, restock charges and any other costs associated with providing the proper installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Only those products listed in Division 26 shall be employed.

PART 3 - EXECUTION

3.1 EQUIPMENT

- A. Connections for a coordination of motors and equipment requiring electrical connections shall include but not be limited to the following:
 - 1. Install motor controllers and disconnect switch for each motor and each piece of equipment.
 - 2. Verify that the motor rotation is correct and reconnect if necessary.
 - 3. Provide separate ground wires in flexible, metal conduit and non-metallic conduit so as to provide an electrically continuous ground path. Ground all equipment.
 - 4. Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection in minimum 24 inch length of liquid tight, flexible, metal conduit.
 - 5. Provide all necessary wiring and connections for interlocking, remote and automatic controls. Installation of equipment and wiring shall be in compliance with shop drawings and manufacturer's recommendations.
 - 6. Where equipment is fed from branch circuit routed in or under the slab, terminate branch circuit at J-box on 2 foot rigid conduit stub-up and make final connection to equipment in liquid tight, flexible, metal conduit. Provide suitable knee brace on conduit stub-up.
 - 7. Where equipment is fed from overhead support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to motor with 24-inch minimum of liquid tight flexible steel conduit.
 - 8. Where nameplate on equipment indicates fuse protection the disconnecting means shall be equipped with time delay fuses.

3.2 APPLIANCES

- A. Connections for and coordination of appliances shall include but not be limited to the following:
1. The basic requirements for motors and equipment specified above shall apply where applicable.
 2. Where cord and plugs are provided with the appliances this contractor shall coordinate the receptacle installation to match. Information on the Drawing as to receptacle type is for bidding purposes only.
 3. Direct connected equipment shall be serviced by disconnecting means.

3.3 OWNER FURNISHED EQUIPMENT

- A. The requirements for equipment furnished by the Owner for installation by this contractor shall include but not be limited to the following:
1. The coordination of the proper delivery scheduling of such equipment.
 2. The receiving and unloading of such equipment at the property line.
 3. The inspection of such equipment for damages, defacement, corrosion, missing components, etc. at the job site. All deficiencies shall be recorded. Deficiencies occurring after inspection shall be corrected by this contractor at his cost.
 4. The safe handling and secure storage of such equipment from unloading to the time of permanent installation.
 5. The completion of field make up of internal wiring as required.
 6. The lamping of equipment.
 7. The installation of accessories on such equipment.
 8. The installation of such equipment including the transportation of the equipment to the installation area, and the installation of all supports, fasteners, canopies, extension, etc. required to insure safe support and adaptation to the finished structural, electrical and architectural conditions.
 9. The final connections and grounding to the building electrical system including all necessary labor and materials including but not limited to junction box extensions, lug change outs, etc.
 10. The testing of such equipment in its final location.

3.4 VARIABLE SPEED DRIVES

- A. Where variable speed drives are utilized for control, the following shall be included in addition to other requirements in this Section:
1. Wiring: Install incoming and outgoing power circuits. All outgoing circuits shall be run in individual conduits. No two shall be run in the same conduit. Make final connections to motor.

END OF SECTION 26 05 14

SECTION 26 05 21 - WIRES AND CABLES (0-1000V)

PART 1 - GENERAL

1.1 DESCRIPTION

A. General

1. Provide 600-volt wire and cable in accordance with the Contract Documents.

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. General: Underwriters' Laboratories labeling of all insulations and jackets.
2. Rubber Insulated Wire and Cables
 - a. ICEA pub. No. S-19-81 (NEMA Pub. No. WC 3): Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b. UL 44: Rubber-Insulated Wires and Cables
3. Thermoplastic Insulated Wire and Cables
 - a. ICEA pub. No. 1 S-614-02 (NEMA Pub. No. WC3): Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b. UL 83: Wires, Thermoplastic-Insulated
4. Cross Linked Thermosetting Polyethylene Insulated Wire and Cables
 - a. ICEA pub. No. S-66-524: (NEMA Pub. No. WC7): Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
 - b. UL 44: Rubber Insulated Wires and Cables
 - c. UL 854: Service-Entrance Cables.
5. Annealed Copper Wire for Conductors
 - a. ASTM B-3: Soft or Annealed Copper Wire
6. Terminal Blocks
 - a. UL 1059
7. Insulation Thicknesses for Individual conductors
 - a. N.E.C. Table 310-13: Conductor Application and Insulations.

1.3 SUBMITTALS

- A. Provide listing of manufacturers proposed in the submittal list identified in Section 26 05 05 of these specifications.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver wire and cable to job site on reels or coils marked in accordance with N.E.C. Section 310-11.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Wire and Cable:

1. Anaconda
2. General Electric Company
3. Hatfield Wire and Cable
4. The Okonite Company
5. Kerite Company
6. Paranite Wire and Cable Division of Essex
7. International, Inc.
8. Pierelli Cable Corporation
9. Phelps Dodge Copper Products Corporation
10. Reynolds Metal Company
11. Rockbestos Products – Cerro Wire and Cable Company
12. Rome Cable Corporation
13. Cyprus Wire and Cable Company
14. Southwire Company
15. Triangle Conduit and Cable Company.

B. Connectors (UL Approved):

1. Hand-Applied:

- a. T&B "Piggy"
- b. 3M Company "Scotchlok"
- c. Ideal Industries "Wing Nut"
- d. Buchanan "Squeeze On"

2. Tool-Applied:

- a. T&B "Stakon" or Series "54475" through "54490"
- b. Ideal Industries "410 Crimp Connector"
- c. Burndy "KA-U" or "YA"
- d. ILSCO "TA", or "AU" or "D"
- e. Buchanan "Wrap Cap"

C. Electrical Tape

1. W.H. Brady "B-500+", "B-500"
2. T&B "E-Z" code Type WBC
3. 3M "Scotch 35" vinyl plastic, electrical
4. Johns-Manville

2.2 WIRE AND CABLE

A. General

1. Provide wire with a minimum insulating rating of 600 volts, except for wire used in 50 volts or below applications for control of signal systems, use 300 volt minimum. Where permitted to be incorporated with other wiring systems, 600 volt wire shall be used for lower voltage wiring systems.
2. Conductor construction and application shall comply with N.E.C. article 310.104. Allowable ampacities shall comply with Table 310.15 (B) (16) or other applicable tables based on temperature and location. In general, wire shall be rated 90° C. Circuits up to and including 100 amperes shall use the 60° C column for ampacities and circuits above 100 amperes shall use the 75° C column for ampacities. For ambient temperatures other than 30° C, use the proper correction factor listed for each table.

B. Conductor

1. Electrical grade, annealed copper, tinned if rubber insulated and fabricated in accordance with ASTM standards. Minimum size number 12 for branch circuits; number 18 for control wiring.
2. The conductors illustrated on the drawings are copper. Except as otherwise noted, aluminum is not permitted.

C. Stranding and Number of Conductors

1. Number 12 and number 10 conductors shall be solid.
2. Cables larger than number 10, stranded in accordance with ASTM Class B stranding designations.
3. Control wires stranded in accordance with ASTM Class B stranding designations.
4. Cables, multi-conductor unless otherwise noted for low-tension systems.

D. Insulated Single Conductors

1. Type THHN – Flame retardant: Heat resistant thermoplastic insulation, nylon jacket rated for 90 C operation. Use for lighting branch circuit wiring installed and passing through the ballast channels of fluorescent fixtures, wiring in metal roof-decks in or near roof insulation in attic or joist spaces, or in raceways exposed to the sun.
2. Type THWN - 75°C: Use in dry or wet locations.

E. Color Coding

1. Provide consistent color coding of all feeders, sub feeders, motor circuits and the likes as follows:

- a. 120/208 volts code
 - 1) Phase A – Black
 - 2) Phase B – Red
 - 3) Phase C – Blue
 - 4) Neutral – White
 - 5) Ground – Green
2. Color-code wiring for control systems installed in conjunction with mechanical and/or miscellaneous equipment in accordance with the wiring diagrams furnished with the equipment. Factory color code wire number 2 and smaller. Wire number 1 and larger may be color coded by color taping of the entire length of the exposed ends.
3. Signal and Communication (100 conductors or fewer per cable): In accordance with Table 5-1, Part 5 of ICEA Pub. S-61-402 (NEMA WC 5).
4. Substitutions for Color-Coded Wire: With approval of Owner's Representative and where color coding cannot be readily provided because of limited quantities involved, either of the following:
 - a. Plastic tape applied spirally and half-lapped over exposed portions of conductors within manholes, boxes and similar enclosures.
 - b. Colored tubing cut and inserted over ends of wire prior to installing terminals.

2.3 CONNECTORS

- A. Make connections, splices and taps and joints with solderless devices, mechanically and electrically secure. Protect exposed wires and connecting devices with electrical tape or insulation to provide protection not less than that of the conductor.
- B. Branch circuit wires (number 10 and smaller):
 1. Hand-Applied
 - a. Coiled, tapered, spring wound devices with a conducting corrosion-resistant coating over the spring steel and a plastic cover and skirt providing full insulation for splice and wired ends. Screw connector on by hand.
 - b. Hydraulic tool of the same lug manufacturer shall be used and hydraulic tool shall emboss on the connector the proper die number for inspection.

2.4 ELECTRICAL TAPE

- A. Specifically designed for use as insulating tape.

2.5 LUBRICANT

- A. Use lubricant only where the possibility of damage to conductors exists. Use only a lubricant approved by the cable manufacturer and one, which is compatible with cable and raceways.

PART 3 - EXECUTION

3.1 WIRE AND CABLE

- A. Provide a complete system of conductors in raceway system. Mount wiring through a specified raceway regardless of voltage application.
- B. Drawings indicate the minimum size wiring for branch circuits. Use No. 12 AWG, minimum. For branch circuits whose length from panel to furthest outlet exceeds 75 feet for 120-volt circuits or 175 feet for 277-volt circuits, use number 10 or larger.
- C. Do not install wire in incomplete conduit runs or until after the concrete work and plastering is completed and moisture is swabbed from conduits. Eliminate splices wherever possible. Where necessary, splice in readily accessible pull, junction or outlet box.
- D. Provide cable supports for all vertical risers where required by code not to exceed the following:

Minimum Conductor Size	Vertical Supports Aluminum	Copper
No. 18 AWG to No. 8 AWG	100 ft.	100 ft.
No. 6 AWG to No. 8 AWG	200 ft.	100 ft.
No. 00 AWG to No. 0000 AWG	180 ft.	80 ft.
250,000 CM to 350,000 CM	135 ft.	60 ft.
350,001 CM to 500,000 CM	120 ft.	50 ft.
500,001 CM to 750,000 CM	95 ft.	40 ft.

- E. Flashover or insulation value of joints shall be equal to that of the conductor. Provide Underwriters' Laboratories listed connectors rated to 600 volts for general use and 1,000 volts for use between ballasts and lamps or gaseous discharge fixtures.
- F. Use terminating fittings, connectors, etc., of a type suitable for the specified cable furnished. Make bends in cable at termination prior to installing compression device. Make fittings tight.
- G. Apply an anti-oxide inhibitor equivalent to "Penetrox" (Burndy) or "Noalox" (Ideal) to all aluminum terminations.
- H. Install wire in raceways and make up terminations in accordance with manufacturer's recommendations using special washers, nuts, etc., as required. Use an accepted wire pulling lubricant equivalent to "Yellow" (Ideal) for all wire number 4 and larger. Strip insulation so as to avoid nicking of wire.
- I. Extend wire sizing for the entire length of a circuit, feeder, etc. unless specifically noted otherwise.
- J. Where multiwire branch circuits (connected to multiple overcurrent devices) are installed in a single conduit, derating adjustments in accordance with NEC 310.15 shall apply. The neutrals shall be counted as current carrying conductors. Shared neutrals are not allowed.

- K. Where a three-phase circuit consisting of (3) three phase wires, (1) one neutral, and (1) one ground wire connected to a single over-current device is installed in a single conduit, derating adjustments outlined in NEC 310.15 shall not apply.
- L. Each main and branch circuit shall have its own neutral conductor. Shared neutral conductors shall not be installed.
- M. Conductors and Insulation Applications
 - 1. Service Entrance: Type THHN-THWN, single conductors in raceway.
 - 2. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
 - 3. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
 - 4. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
 - 5. Exposed Branch Circuits in attic or interstitial space: Type THHN-THWN, single conductors in raceway, Armored cable Type AC or Metal-clad cable Type MC where permitted by N.E.C. articles 320 and 330.
 - 6. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Armored cable, Type AC Metal-clad cable or Type MC metal clad cable where permitted by N.E.C. articles 320 and 330.
 - 7. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in galvanized rigid steel conduit.
 - 8. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
 - 9. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable suitable for use in Plenums. Use metal raceways where required in Section 28 31 02 Multiplex Fire Alarm Systems.
 - 10. Class 1 Control Circuits: Type THHN-THWN, in raceway.
 - 11. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes Power-limited tray cable, in cable tray.
 - 12. Use Type AC/MC cables for fixture whips not to exceed 6 ft. length.

3.2 INSTALLATION

A. General

- 1. Provide tools, equipment and materials to pull all wire and cable into place and to make required splices and termination.

B. Wire and Cable in Conduit, Duct or Wireway

- 1. Utilize roller bearing swivel to prevent twisting of cable entering conduit or duct.
- 2. Take precautions to avoid the entrance of dirt and water into conduit and ducts.
- 3. Clean existing conduits and ducts to remove any pulling compound prior to pulling new cables.
- 4. Do not damage conductor insulation, braid jacket or sheath.
- 5. Do not bend conductors to less than manufacturer's recommended radius.
- 6. Lubricate cable if required for pulling using powdered soapstone or pulling lubricants; do not use oils or greases.

7. Make splices only in pull boxes, junction boxes and outlet boxes.
8. Utilize cable reels on jacks for pulling through pull boxes, ducts and conduits so bends will not be excessive and conductors will not touch sharp edges; use feeding tube where required.
9. For large diameter cables, utilize properly sized pulling grips (open-ended woven basket, two to four feet long, of ductile steel).
10. Do not exceed maximum recommended pulling tension of wire and cable.

C. Splices, Terminations and Connections

1. General: Except where lugs are furnished with equipment, provide terminals and connectors suitable for quantity, conductor size and direction of entry (top or bottom).
2. Insulated Flanged Terminals: Install for connection of conductors No. 12 AWG and smaller to device terminals; do not exceed three terminals at single connections.
3. Circumferential Compression Type Connectors: Install for splices and connections No. 4 AWG and larger.
 - a. Use for incoming and outgoing cable connections at enclosures and for ground connections.
 - b. Use manufacturer's approved tool and correct hex head which embosses die number on connector lug.
 - c. Make crimped indentations parallel with conductor.
 - d. Fill voids and irregularities with insulation putty.
 - e. Cover neatly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two directions.
 - f. Use spring-held bakelite covers over splices or taps only with approval of Owner's representative.
4. Conductor Arcproofing
 - a. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape, except if boxes or compartments are barriered.
 - b. Provide tape "Scotch" Irvington Tape No. 7700 or Plymouth Rubber Co. Slipknot No. 30 to provide an insulation capable of withstanding a 200-amp arc for not less than 30 seconds.
 - c. Apply tape in a single layer, half-lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with a random wrap of 1/2 inch (15mm) wide pressure sensitive, plastic film tape color coded as specified in the "conductor identification" paragraph.

D. Wire Marker Identification Labels

1. Utilize labels for all feeders and for those circuits where individual conductor identification is indicated on Drawings.
2. Apply to wires and cables at terminals and in all pull junction and splice boxes.
3. Do not cut and splice multi-conductor control cable for purpose of labeling.
4. Clean surfaces before applying labels.
5. Tag and tape all spare wiring.

3.3 FIELD QUALITY CONTROL

A. Testing

1. Test system wiring for continuity, grounds and short circuits prior to connection of any equipment.
2. Test final equipment connections for proper torque.
3. Insulation Resistance of Feeders and Subfeeders
 - a. Test with megger for insulation resistance
 - b. Locate faults and replace sections found to have faulty insulation
 - c. Demonstrate installation is free of grounds and short circuits and that insulation resistance complies with ICEA values.
4. Test direct burial cables after completion of backfilling.

END OF SECTION 26 05 21

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide a low impedance grounding system in accordance with the Contract Documents.
 - 1. Purpose of grounding system:
 - a. Adequate path for ground fault currents.
 - b. Safety to personnel from accidental electric shock hazards.
 - c. Prevention of hazardous discharge of static electricity.
 - 2. Whether or not indicated on Drawings, provide continuous ground path for all electrical circuits from point of utilization back to source through ground wires, bonded metallic conduit runs, grounded cable trays, and related items.
- B. Electrical Equipment: Provide complete exterior and interior grounding system, including grounding provisions for high and low voltage switchgear and transformers, motor control centers, cable trays, lightning arrestors, motors, emergency generators and other equipment as indicated on Drawings or required by applicable standards.
- C. Miscellaneous Equipment: Provide complete grounding for chimneys, smokestacks, flag poles, metal lighting standards, substation fences, metal antennas, supports for elevated metal floors, steel framework of buildings, elevators, and other equipment as indicated on Drawings or required by applicable standards.
- D. Related Work Specified in Division 26
 - 1. Section 26 05 10 – Testing, Acceptances and Certifications
 - 2. Section 26 05 14 – Equipment Connections and Coordination
 - 3. Section 26 05 21 – Wires and Cables
 - 4. Section 26 05 33 – Raceways and Boxes
 - 5. Section 26 24 13 – Switchboards
 - 6. Section 26 27 26 – Wiring Devices
- E. Related Work Specified in Other Divisions of these Specifications.
 - 1. Concrete
 - 2. Metallic water piping

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Underwriters Laboratory Standard No. U.L. 467.
2. ANSI C-1 1978
3. IEEE Standards No. 142-1982 and No. 80
4. National Electrical Safety Code
5. NFPA
6. Federal Information Processing Standards, Publication #94

1.3 SUBMITTALS

- A. Provide a complete set of shop drawings showing service grounding methods as called for on the Contract Documents.
- B. Submit test reports certifying resistance values for buried or driven grounds and water pipe grounds.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Ground Connectors and Clamps; Grounding Bushings and Locknuts.

1. All Steel Equipment, Inc.
2. Appleton Electric Company
3. Electrical fitting Corp. (EFCOR)
4. Gedney Electric Company
5. Iliscol – Div. Of Bardes Corp.
6. Midwest Elec. Mfg. Company
7. Steel City Div., Midland Ross Corp.
8. Thomas & Betts
9. O-Z/Gedney Co.

- B. Welding Type Ground Connectors:

1. Burndy Engineering Company (Thermoweld)
2. Erico Products, Inc. (Cadweld)

- C. Compression Type Grid Connectors:

1. Thomas & Betts Company – Series, 53,000
2. Burndy Corp. – Cat No. YGL-C

- D. Ground Rods and Clamps

1. Copperweld Steel Company
2. ITT Blackburn Corp.
3. J.A. Weaver Company

- E. Bonding Jumpers for Hinged-Joints in Cable Tray: Husky/Burndy Cat. No. AF5-C.

F. Electrical Insulating Tapes:

1. Self-Fusing: 3M Company No. 23
2. Vinyl: 3M Company No. 33+

G. Compound for Compression Connectors:

1. Thomas & Betts Co. – Kopr/Shield
2. Brundy Engineering Company – Penetrox "E"

2.2 MATERIALS

- A. Ground Cables: Bare or green color coded, insulated, annealed stranded tinned copper wire as indicated on Drawings; insulated wire to conform with requirements of Section 26 05 21.
- B. Mechanical Connectors: Tin-plated aluminum alloy, UL approved and stamped for use with aluminum or copper conductors.
- C. Ground Rods:
1. Copper-clad steel fabricated by molten welding process
 2. Diameter: 3/4 inch.
 3. Length: 10 feet
- D. Ground Lugs and Connectors for Cable Tray: Tin-plated aluminum alloy suitable for use with aluminum or copper conductors.

2.3 GENERAL

- A. Furnish and install electrical grounding systems as indicated on the construction documents and as specified herein.
- B. Grounding systems shall be installed in accordance with the requirements of the local authorities, NEC Section 250, and subject to the approval of the Architect/Engineer.
- C. Install equipment grounding conductors in all feeders and branch circuits.
- D. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.

- E. All ground wires and bonding jumpers shall be stranded copper installed in conduit. All ground wires shall be without joints and splices over its entire length.
- F. The system neutral shall be grounded at the service entrance only and kept isolated from grounding systems throughout the building.
- G. Each system of continuous metallic piping and ductwork shall be grounded in accordance with the requirements of the NEC Section 250.
- H. Mechanical equipment shall be bonded to the building equipment grounding system. This shall include but is not limited to, fans, pumps, chillers, etc.
- I. Metallic conduits and portions of metallic piping and duct systems which are isolated by flexible connections, insulated couplings, etc., shall be bonded to the equipment ground with a flexible bonding jumper, or separate grounding conductor.
- J. Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings and other metal noncurrent-carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any non-conductive paint, enamel, or similar coating shall be removed at threads, contact points and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

2.4 SERVICE GROUNDING SYSTEM

- A. Provide a bare copper bus, wall mounted within the electrical switchboard room. Bus shall be 1/4" thick by 2" wide by 4' long.
- B. Extend two (2) service grounding connectors in separate raceways from wall mounted ground bus to ground bus in each switchboard.
- C. Extend conductors in raceway from service ground bus to switchboard ground bus as indicated on the drawings.

2.5 SWITCHBOARDS

- A. Bond each section of switchboards unit substations and primary switchgear housing and service conduits entering same to ground bus.

2.6 SEPARATELY DERIVED SYSTEMS

- A. Equipment grounding conductors shall be provided for separately derived systems and shall be grounded to building steel, cold water pipes, etc., or an alternate grounding means. Equipment grounding shall consist of but not to be limited to the following:
 - 1. Power transformer

2.7 RECEPTACLES

- A. Receptacles shall be grounded to the outlet box by means of a bonding jumper between the outlet box and the receptacle-grounding terminal.

2.8 OUTDOOR EQUIPMENT

- A. Outdoor enclosures shall be connected with No. 4 bare copper installed not less than 24 inches below grade, connecting to the indicated ground rods or ground grid. Fence and equipment connections shall be bare copper No. 4. Fence shall be grounded at each gate post and corner post. Each gate section shall be bonded to the fence post through a 1/8-inch by one-inch flexible braided copper strap and approved clamps. Transformer neutral connection shall be sized, based on a separately derived system, N.E.C. table 250.66.

2.9 CONCENTRIC KNOCKOUTS

- A. Provide grounding type bushings for conduits terminated through multiple concentric knockouts not fully knocked out, on inside of electrical enclosures. Ground bushing with #12 bare copper to ground bus within enclosure or to enclosure proper where a ground bus is not present.

2.10 TOGGLE SWITCHES

- A. Provide grounding clip on each toggle switch. Mount over device mounting strap such that contact is made between mounting strap, screw, faceplate and outlet box.
- B. Provide devices with ground screw where required by local authorities and bond this with #10 conductor to associated outlet box.

2.11 GROUND METHODS

- A. Ground rods shall be copper-clad steel not less than 3/4 inch in diameter, ten (10) feet long, driven full length into the earth. The maximum resistance shall not exceed 5 ohms. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than six (6) feet on center. If sectional type rods are used, two additional sections may be coupled and driven with the first rod.
- B. Ufer grounding system shall consist of a bare copper cable minimum forty (40) feet in length placed in the concrete foundation at not more than three inches or less than one inch from bottom, where concrete is in direct contact with the earth.
- C. The metal frame of the building, where effectively grounded.
- D. The metal underground water piping system used for grounding shall be in direct contact with the earth for ten feet or more and shall be electrically continuous. Provide bonding jumpers at water meter and at insulating joints.

- E. Steel reinforcing bars used for grounding shall be encased by at least two inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth. Reinforcing bars shall be minimum 1/2 inch diameter and consisting of twenty feet of one or more steel reinforcing bars.
- F. All bonding jumpers for the above grounding systems shall be sized in accordance with NEC Section 250-102.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding Grid:

1. Install grounding grids with ground rods and cables as indicated on Drawings. At a minimum grounding grid shall consist of a counterpoise layout. Counterpoise shall include (3) 3/4" x 10' long ground rods space 10' apart in a triangular fashion connected together with bare #4 copper cad welded to each rod.
2. Avoid splices in ground cables.
3. Connectors:
 - a. Install mechanical connectors in above ground accessible locations only.
 - b. Install welding type ground connections or connection type grid grounding connectors underground, in manholes, or at inaccessible locations only.
 - c. Thoroughly clean contact surfaces before making connections.
 - d. Apply manufacturer's compound for compression connectors to conductors prior to crimping.
 - e. Make connections using compression type grid grounding connectors with approved manufacturer's hydraulic tool and correct size hex head die which, for inspection, embosses proper die number on connectors.
4. Make connection from ground grid to equipment ground buses as shown on Drawings.
5. Provide for future disconnection for testing where building ground loop or grid connects to exterior or interior steel.
6. Wrap conductors with self-fusing electrical tape and cover with vinyl electrical tape where insulation of grounding system connection is required.

B. Cold Water Pipe Grounding:

1. Make connection with clamp type fitting; do not damage water pipe.
2. Bond ground conductor and its conduit to water pipe.
3. Install No. 4/0 AWG bonding jumper with ground clamps around water meter.

C. Ground Conductors:

1. Size as shown on Drawings or as required by NEC Table 250-66 and 250.122.
2. Where ground cables are required, install insulated copper ground conductors in steel conduit, or as indicated.
3. Where ground cable is protected by metallic conduit, bond cable to conduit at both ends.

4. Connect ground conductors in cables and in conduit to appropriate ground buses (as in switchgear, motor control centers, and distribution panelboards) or directly to metallic enclosure if no ground bus is provided.

D. Conduit Attachment to Electrical Equipment:

1. Ground conduits to metal framework of electrical equipment with double locknuts or grounding bushings and bonding jumpers unless otherwise noted.
2. Install bonding jumpers at all electrical equipment to provide continuous ground return path through conduit.
3. Install NEC approved bonding jumpers across expansion fittings between conduit sections for ground path continuity.
4. Bond conduits to cable tray where conduit enters or exits tray.
5. Where motors or other utilization equipment are connected to electrical system with flexible conduit, ground by one of the following:
 - a. Flexible metal conduit alone if length is 6 feet or less, conduit is terminated in fitting approved for purpose, and circuit conductors contained therein are protected by overcurrent devices rated 20 amperes or less.
 - b. External jumper across flexible conduit.
 - c. Flexible conduit containing integral ground wire.
 - d. Do not install external jumpers for flexible conduit connections to kitchen equipment.

E. Receptacles and Switches:

1. Install bonding jumpers between outlet box and receptacle grounding terminal except where contact device or yoke is provided for grounding purposes.

F. Wireways: Install grounding jumpers for bonding between wireway and other panelboards, conduit, switchgear, motor control centers, and at any other point where solid connection would otherwise not be provided in supporting system to insure continuous ground.

G. Panelboards: Install bonding jumpers inside (if possible) all panelboards to bond feeder conduit to panelboards, except ground panelboards containing branch circuits each having less than 150 amperes current carrying capacity, with two standard locknuts and bushings, one inside and one outside, run up wrench tight.

H. Sheet Metal Boxes:

1. Install bonding jumpers inside (if possible) all sheet metal boxes containing one or more feeders with current carrying capacity of 150 amperes or greater, to bond one conduit with another.
2. Ground boxes containing branch circuits only or feeders each less than 150 amperes current carrying capacity, with two standard locknuts and bushings, one inside and one outside, run up wrench tight.
3. Panelboards: Install bonding in sheet metal boxes in systems over 600 volts, regardless of current carrying capacity.

- A. Resistance Values for System and Equipment Grounds: For each ground rod and ground grid.
1. Acceptable Testing Equipment: Vibroground by Associated Research, Inc.; or Megger Earth Tester by James G. Biddle Co.
 2. Method: Three (3) electrode fall of potential as prescribed by instrument manufacturer.
 3. Drive additional ten-foot ground rods spaced eight feet apart, if necessary, until total resistance of system is measured at five ohms or less.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Show support details if different from methods specified or shown on the drawings.
- B. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 - PRODUCTS

2.1 ANCHORING DEVICES

- A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.
- B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.
- C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.
- D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.
- E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.2 CAST-IN-PLACE CONCRETE INSERTS

- A. Continuous Slotted Type Concrete Insert, Galvanized:
 - 1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
 - 2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
 - 3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
 - 4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.
- B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.
- C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge-shaped heads.

2.3 MISCELLANEOUS FASTENERS

- A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.
1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
 2. Lag Bolts: FS FF-B-561, square head type.
 3. Machine Screws: FS FF-S-92, cadmium plated steel.
 4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
 5. Wood Screws: FS FF-S-111 flat head carbon steel.
 6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
 7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
 8. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.
- B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.4 TPR (THE PEEL RIVET) FASTENERS

- A. 1/4 inch diameter, threadless fasteners distributed by Subcon Products, 315 Fairfield Road, Fairfield, NJ 07004 (800) 634-5979.

2.5 POWDER DRIVEN FASTENER SYSTEMS

- A. Olin Corp.'s Ramset Fastening Systems, or Phillips Drill Company Inc.'s Red Head Powder Actuated Systems.

2.6 HANGER RODS

- A. Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.7 "C" BEAM CLAMPS

- A. With Conduit Hangers:
1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.
 2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.
 3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay-in hanger.

B. For Hanger Rods:

1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erco Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.
2. For 3/8 Inch Hanger Rods: Caddy/Erco Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.
3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.
4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.
5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.8 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:

1. Phosphate and baked green enamel/epoxy.
2. Pre-galvanized.
3. Electro-galvanized.
4. Hot dipped galvanized.
5. Polyvinyl chloride (PVC), minimum 15 mils thick.

C. Fittings: Same material and finish as channel.

D. UL Listed Systems:

1. B-Line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).
2. Grinnell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).
3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).
4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).
5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.9 MISCELLANEOUS FITTINGS

A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.

B. Pipe Straps:

1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series.

2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).
- C. Deck Clamps: Caddy/Erco Products Inc.'s DH-4-T1 Series.
- D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.
- E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:
 1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.
 2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.
 3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHHE, or Crouse-Hinds Co.'s UNH-1.
 4. Eyelet: Unistrut Corp.'s M2250.
 5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.
 6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.
- F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erco Products Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.
- B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.
- C. Make attachments to structural steel wherever possible.

3.2 FASTENER SCHEDULE

- A. Material:
 1. Use cadmium or zinc coated anchors and fasteners in dry locations.
 2. Use hot dipped galvanized or stainless-steel anchors and fasteners in damp and wet locations.
 3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.

B. Types and Use: Unless otherwise specified or indicated use:

1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.
3. Toggle bolts to fasten items to hollow masonry and stud partitions.
4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.
5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
 - a. Do not use powder driven drive pins or expansion nails.
 - b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
 - c. Do not support a load, in excess of 250 lbs. from any single welded or powder driven stud.
 - d. Do not use powder driven fasteners in precast concrete.

3.3 ATTACHMENT SCHEDULE

A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.

1. Make attachments to steel bar joists at panel points of joists.
2. Do not drill holes in main structural steel members.
3. Use "C" beam clamps for attachment to steel beams.

B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:

1. Attachment to Steel Roof Decking (No Concrete Fill):

- a. Decking With Hanger Tabs: Use deck clamps.
- b. Decking Without Hanger Tabs:
 - 1) Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.
 - 2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.

2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):

- a. Before Fill Has Been Placed:
 - 1) Use thru-bolts and fish plates.

- 2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.
- b. After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs from a single welded stud.
3. Attachment to Cast-In-Place Concrete:
 - a. Fresh Concrete: Use cast-in-place concrete inserts.
 - b. Existing Concrete: Use anchoring devices.
4. Attachment to Cored Precast Concrete Decks:
 - a. New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed concrete fill over decks.
 - b. Existing Construction: Toggle bolts may be installed in cells for a maximum load of 50% of that allowed for new construction.
5. Attachment to Hollow Block or Tile Filled Concrete Deck:
 - a. New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.
6. Attachment to Waffle Type Concrete Decks:
 - a. New Construction:
 - 1) Use cast-in-place concrete inserts in fresh concrete.
 - 2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.
7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.
8. Attachment to Precast Concrete Tee Construction:
 - a. New Construction:
 - 1) Use tee hanger inserts between adjacent flanges.
 - 2) Use thru-bolts and fish plates, except at roof deck without concrete fill.
 - b. Existing Construction:
 - 1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.
 - c. Do not use power driven fasteners.
 - d. Exercise extreme care in drilling holes to avoid damage to reinforcement.

9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.
- Under 15 lbs Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2 inch long wood screws, or 2 No. 16 x 1-1/2 inch long drive screws.
 - Over 15 lbs Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIAMETER
15 lbs to 30 lbs	3/8 x 1-3/4 inches	3/8 inch
31 lbs to 50 lbs	1/2 x 2 inches	1/2 inch
Over 50 lbs to load Limit of structure.	Use bolt & nut	5/8 inch

- Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.
 - Do not make attachments to the diagonal or vertical members of wood trusses.
 - Do not make attachments to the nailing strips on top of steel beams.
10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
- Support and attach outlet boxes so that they cannot torque/twist. Either:
 - Use bar hanger assembly, or:
 - In addition to attachment to the stud, also provide far side box support.

3.4 CONDUIT SUPPORT SCHEDULE

- Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.
- Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.
 - Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.
- Use "C" beam clamps and hangers where conduit is supported from steel beams.
- Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.

1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.
- E. Use channel support system supported from structural steel for multiple parallel conduit runs.
- F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.
 1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.
 2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.5 LIGHTING FIXTURE SUPPORT SCHEDULE

- A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.
 1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
 - a. Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.
 2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
 - a. Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.
- B. Specific Installations Where Fixtures May Be Supported From New Ceilings Being Installed By Construction Work Contractor:
 1. Support surface mounted fixtures directly from plywood backed gypsum board ceilings.
 2. Support surface mounted fixtures directly from framing or furring members of fire rated suspended ceilings (double gypsum board).
 3. Support recessed mounted fixtures directly from furring members of furred gypsum board ceilings.
 4. Support recessed mounted fixtures directly from the suspension system of suspended acoustical ceilings. Exception: Support each fixture weighing more than 50 pounds (including lamps) independent of the suspended ceiling grid.
 5. Deliver documents which state actual fixture weights and indicate fixture locations to the Construction Work Contractor (thru the Director's Representative).
- C. Number of Supports For Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer or shown on the drawings.

1. Commercial and Industrial Fixtures:
 - a. Support individual fixtures less than 2 feet wide at 2 points.
 - b. Support continuous row fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.
 - c. Support individual fixtures 2 feet or wider at 4 corners.
 - d. Support continuous row fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.
 - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

D. Number of Supports For Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.

1. Commercial and Industrial Fixtures:
 - a. Support individual fixtures 2 feet long or less at 2 points.
 - b. Support individual fixtures over 2 feet long at 3 points.
 - c. Support continuous row fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.
 - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

3.6 CHANNEL SUPPORT SYSTEM SCHEDULE

- A. Use channel support system where specified or indicated on the drawings.
- B. Channel supports may be used, as approved, to accommodate mounting of equipment.
- C. Material and Finish:
 1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.
 2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.
 3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide raceways in accordance with the Contract Documents.
- B. Related work in other sections:
 - 1. Section 26 05 00 – Common Work Results for Electrical
 - 2. Section 26 05 10 – Testing, Inspection and Certification
 - 3. Section 26 05 26 – Grounding and Bonding
 - 4. Section 26 05 29 – Hangers and Supports for Electrical Systems
 - 5. Section 26 05 53 – Identifications for Electrical Systems
 - 6. Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Rigid Steel Conduit
 - a. UL Standards UL-6
 - b. A.N.S.I. C80-1
 - c. Federal Specification WW-C-581E
 - 2. Intermediate Metallic Conduit
 - a. UL Standard UL-1242
 - b. Federal Specification WW-C-581E
 - 3. Electrical Metallic Tubing
 - a. UL Standard UL-797
 - b. A.N.S.I. C80-3
 - c. Federal Specification WW-C-563
 - 4. Flexible Steel Conduit
 - a. UL Standard UL-1
 - 5. Liquid Tight Flexible Conduit
 - a. UL Standard UL-360

6. Non-Metallic Conduit
 - a. UL Standard UL-651
 - b. A.N.S.I. Standard F512
 - c. N.E.M.A. Standard TC-2
 - d. Federal Specification GSA-FSS and W-C-1094-A
 - e. Corps of Engineers Specification CE-303:01
7. Wireways and Auxiliary Gutters
 - a. UL Standard UL-870
8. Rigid Aluminum Conduit
 - a. A.N.S.I. C80.5

1.3 SUBMITTALS

- A. Provide manufacturer's catalog cuts of fittings.
- B. Indicate duct banks or multi-trade coordinated shop drawings.
- C. Submit shop drawings or catalog descriptive data on boxes exceeding twenty-four (24") inches for any one dimension.
- D. Submit shop drawings or catalog descriptive for floor boxes and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
- B. Conduit Bodies:
 1. Adalet-PLM
 2. American Electric
 3. Appleton Electric Co.
 4. Carlon
 5. Crouse-Hinds Division, Cooper Industries, Inc.
 6. Delta-Industrial Products
 7. Killark Electric Mfg. Co.
 8. Kraloy Products Co.
 9. O-Z/Gedney
 10. Spring City Electrical Mfg. Co.

C. Fittings:

1. Appleton Electric Co.
2. O-Z/Gedney
3. RACO
4. Steel City
5. Thomas and Betts

D. Wireway:

1. GS Metals Corp.
2. Hoffman Engineering Co.
3. Keystone/Rees, Inc.
4. Square D Co.

E. Surface Metal Raceway:

1. B-Line Systems, Inc.
2. GS Metals Corp.
3. Hoffman Engineering Co.
4. Square D Co.
5. The Wiremold Co.

2.2 RACEWAY TYPES

A. Standard Threaded Rigid Steel Conduit

1. Rigid conduit, heavy wall, galvanized.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

B. Intermediate Metallic Conduit

1. Light weight, rigid steel conduit, galvanized.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

C. Electric Metallic Tubing

1. Continuous, seamless tubing, galvanized or sheradized on the exterior, coated on the interior with a smooth hard finish of lacquer, varnish, or enamel.
2. All couplings, connectors, etc., used in conjunction with this raceway, which are two (2") inches in size and smaller shall be steel compression gland fittings, "Tomic" tap-on or "Tomic" compression type. Conduits 2 1/2 inch size and larger may use set screw type which employ four (4) set screws per fitting.
3. EMT is not allowed in concrete.

D. Flexible Steel Conduit

1. Single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel.
2. Maximum length: Six (6) feet.

3. Each section of raceway must contain a bonding wire at each end and sized as required. Provide connectors with insulating bushings.
4. Squeeze-type fittings.

E. Liquid Tight Flexible Electrical Conduit

1. Same as flexible steel conduit except with tough, water-tight plastic outer jacket.
2. Fittings: Cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings which thread to interior of conduit. Spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.

F. Non-Metallic Raceway

1. Composed of polyvinyl chloride suitable for 90 degrees C.
2. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years experience in manufacturing the products.
3. Materials must have a tensile strength of 7,000-7,200 psi at 73.4 degrees F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.
4. All joints shall be solvent cemented in accordance with the recommendations of the manufacturer.

G. Wireways and Auxiliary Gutters

1. Of sizes and shapes indicated on the drawings and as required.
2. Provide all necessary elbows, tees, connectors, adaptors, etc.
3. Hinged cover secured with captive screws.
4. Wire retainers not less than twelve (12") inches on center.

H. Duct Banks

1. Provide duct banks and concrete encasements for both interior and exterior work as indicated on the drawings for all circuits in excess of 600 volts and for all utility company feeders, and as otherwise indicated.
2. Reinforce duct banks with steel where such duct banks are positioned beneath roads and parking areas.
3. Concrete shall be minimum $f_c = 3,000$ pounds per square inch.
4. At building walls and at manhole walls, provide raceways of rigid steel, one size larger than the specified raceway, for a length of five (5) feet. Pitch conduit away from building at every point where duct bank enters the building or equipment.
5. Support raceways installed in duct banks every five (5) feet to assure correct alignment.
6. Duct joints shall be staggered to provide maximum linear strength.
7. Terminate raceways with flared bells to enable ease of pulling cable and to eliminate stress on the cable. Free bells and raceway terminations of burrs and rough edges.
8. Provide concrete markers at grade where duct banks are stubbed out for future use.
9. Install utility duct banks not less than thirty (30") inches below grade top elevation.
10. Red dye inhibiting agents shall be employed in the concrete mix for power duct banks.
11. Provide rigid steel elbows for vertical risers.
12. Provide yellow vinyl tracer ribbon six (6") inches below grade above each duct bank buried in backfill.

I. Aluminum Conduit

1. Rigid conduit heavy wall.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

2.3 OUTLET, JUNCTION, AND PULL BOXES

A. Cast Type Conduit Boxes, Outlet Bodies and Fittings

1. Provide surface mounted outlet and junction boxes, in indoor locations, where exposed to moisture and all outdoor locations.
2. Requirements

Type Conduit	Box Material	Type Hubs
Rigid Steel & IMC	Ferrous Alloy	Inside Thread
Electrical Metallic Tubing	Ferrous Alloy or Inside Thread with Adapter	Compression

3. Covers: Cast or sheet metal unless otherwise required.
4. Tapered threads for hubs.

B. Galvanized Pressed Steel Outlet Boxes

1. General
 - a. Pressed steel galvanized or cadmium-plated, minimum of four (4") inches octagonal or square, with galvanized cover or extension ring as required.
2. Concrete Box
 - a. Four (4") inch octagons with a removable backplate and 3/8" fixture stud, if required. Depth of box shall allow for a minimum of one (1") inch of concrete to be poured above the backplate.
3. Switch and Receptacle Box, Indoors
 - a. Nominal four (4") inches square, 1-1/2" or 2-1/8" deep as required, with raised cover unless otherwise indicated on drawings.
4. Lighting Fixture Box
 - a. Four (4") inch octagon with 3/8" fixture stud.
 - b. For suspended ceiling work, four (4") inch octagon with removable backplate where required, and two (2) parallel bars for securing to the cross-furring channels and extend flexible conduit to each fixture.
5. Plug any open knockouts not utilized.

C. Sheet Steel Boxes Indoors

1. No. 12 USS gauge sheet steel for boxes with maximum side less than forty (40") inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
2. No. 10 USS gauge sheet steel for boxes with maximum side forty (40") to sixty (60") inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners.
3. No. 10 USS gauge sheet steel riveted or welded to 1-1/2" by 1-1/2" by 1/4" welded angle iron framework for boxes with a maximum side exceeding sixty (60") inches and more than 1,500 square inches in area.
4. Covers
 - a. Same gauge steel as box.
 - b. Subdivided single covers so no section of cover exceeds fifty (50) pounds.
 - c. Machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required; maximum spacing twelve (12") inches.
5. Paint
 - a. Rust inhibiting primer; ANSI No. 61 light gray finish coat.
6. Where size of box is not indicated, size to permit pulling, racking and splicing of cables.

D. Pull and Splice Boxes, Outdoors

1. Aluminum reinforced, with removable covers secured by brass machine screws.
2. Where size of box is not indicated, size to permit pulling, racking, and splicing of the cables.
3. Braze a ground connector suitable for copper cables to the inside of the box.

E. Junction Box, Sidewalk Type

1. Cast iron, hot-dipped galvanized with threaded conduit entrance hubs, flanged, reinforced checkered cover, gasketed with pry bar slots and countersunk stainless-steel screws.

F. Identification Labels

1. Acceptable Manufacturers
 - a. W.H. Brady Company (Style A)
 - b. Thomas & Betts Company (T&B), Style A
2. Plasticized Cloth
 - a. Non-conductive
 - b. Waterproof
 - c. Capable of withstanding continuous temperatures of 235 degrees F and intermittent temperatures to 300 degrees F.
 - d. Overcoating for protection against oil, solvents, chemicals, moisture, abrasion and dirt.

3. Heavy, thermo-resistant industrial grade adhesive, for adhesion of label to any surface without curling, peeling or falling off.
4. Legends
 - a. Sharp, bold face, two-inch black letters on "Alert" orange background.
5. Label Designations: Nominal System Voltages Applied to the covers of all medium and low voltage pull, splice and junction boxes.
 - a. 208 volts

PART 3 - EXECUTION

3.1 APPLICATION OF RACEWAYS

- A. The following applications must be adhered to except as otherwise required by Code. Raceways not conforming to this listing must be removed by this Contractor and replaced with the specified material at this Contractor's expense.

B. Raceway Types Application

Rigid Steel Application: Where installed in concrete within the building, in or under slabs within the building, where exposed to mechanical injury, where specifically required, indoors where exposed to moisture and where required by codes and for all circuits in excess of 600 volts.

I.M.C. Application: Same as standard threaded rigid steel conduit.

E.M.T. Application: Use in every instance except where another material is specified. Strictly prohibited in concrete or in contact with earth or fill.

Flexible Steel Applications: Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings at bus duct takeoffs, at all transformer or equipment raceway connections where sound and vibration isolation is required. Maximum length: 6'-0".

Liquid-Tight
Flexible Conduit Applications: Use in areas subject to moisture where flexible metal conduit is permitted, at connections to all motors, and all raised floor areas.

Non-Metallic Conduit Application:

- a. Schedule 40 – Outside the building, where raceways are in concrete, below grade levels, for raceways in duct banks.
- b. Schedule 80 – Where specifically called for on the drawings for underground raceways outside of the building which are not

encased in concrete. Also for secondary conductors of cold cathode lighting systems.

3.2 RACEWAY SYSTEM IN GENERAL

- A. Provide raceways for all wiring systems. All wiring shall be installed in EMT unless otherwise noted or required by Code. 277/480 volt wiring must be kept independent of 120/208 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Where non-metallic raceways are utilized, provide sizes as required with the grounding conductor considered as an insulated additional conductor. Minimum size, 3/4 inch for branch circuits, and one (1") inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.
- B. Install capped bushings on raceways as soon as installed and remove only when wires are pulled. Securely tie embedded raceway in place prior to embedment. Raceways installed below or in floor slabs must extend a minimum of four (4") inches above the finished slab to the first connector. Lay out the work in advance to avoid excessive concentrations of multiple raceway runs.
- C. Locate raceways so that the strength of structural members is unaffected and they do not conflict with the services of other trades. Install one (1") inch or larger raceways, in or through structural members (beams, slabs, etc.) only when and in the manner accepted by the Architect/Engineer. Draw up couplings and fittings full and tight. Protect threads from corrosion with one (1) coat red lead or zinc chromate after installation.
- D. Above Grade-Defined as the area above finished grade for a building exterior and above top surface of any slabs (or other concrete work) on grade for a building interior. Above-grade raceways shall comply with the following:
 - 1. Install raceways concealed except at surface cabinets and for motor and equipment connection in electrical and mechanical rooms. Install a minimum of six (6") inches from flues, steam pipes, or other heated lines.

Provide flashing and counter-flashing for waterproofing of raceways, outlets, fittings, etc., which penetrate the roof. Route exposed raceways parallel or perpendicular to building lines with right-angle turns and symmetrical bends. Run raceways in or under slabs in a direct line and, where possible, with long sweep bends and offsets. Provide sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways. Waterproof sleeved raceways where required.
 - 2. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding conductor at building expansion joints and between buildings or structures and where required to compensate for raceway or building thermal expansion and contraction. Provide expansion fittings every 200 feet on outdoor conduit.
 - 3. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduit in a junction box, which after completion, is accessible to facilitate future branch circuit extension.
 - 4. Provide raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.) in special occupancy area, as required. Provide conduit seal-offs where portions of an

interior raceway system pass through walls, ceiling, or floors which separate adjacent rooms having substantially different maintained temperatures, as in refrigeration or cold storage rooms.

5. Protect metal raceways in earth or fill with two (2) coats of asphalt base paint. Touch up abrasions and wrench marks after conduit is in place.
6. In lieu of the above, protect raceways with a minimum of twenty (20) mil tape approved for the purpose and overlapped a minimum of one half tape width.
7. Provide drag wire in spare or empty raceways. Allow five (5) feet of slack at each end and in each pull box. Tag both ends of wire denoting opposite end termination location with black India ink on flameproof linen tag.
8. Install pull-wire in empty raceways. Use polypropylene on monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inches of slack at each end of pull-wire.

E. Below Grade

1. Defined as the area below finished grade for a building exterior and below or within the bottom floor slab for a building interior. Below grade raceways to comply to the following:
 - a. Project below-grade raceways four (4") inches minimum above floor or equipment foundation. Install exterior underground conduits twenty-four (24") inches minimum below finished grade. Do not penetrate waterproof membranes unless proper seal is provided.

- F. No raceway may be installed in a concrete slab except with the permission of the Structural Engineer and with the written consent of the Owner. Conduits embedded in structural concrete slabs shall have the following minimum thickness and shall conform to the following:

Raceway Size	Minimum Thickness of Concrete Slab
3/4"	4-1/2"
1"	5"

1. Unless specifically approved in writing, raceways 1-1/4 inch size and larger, shall not be installed in structural concrete slabs.
2. In no case will installation of raceways be permitted to interfere with the proper placement of principal reinforcement.
3. Raceways in structural slabs shall be placed between the upper and the lower layers of reinforcing steel. This will require careful bending of conduits.
4. Raceways embedded in concrete slabs shall be spaced not less than eight (8") inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
5. Raceways running parallel to slab supports, such as beams, columns, and structural walls, shall be installed not less than twelve (12") inches from such supporting elements.
6. To prevent displacement during concrete pour of lift slab, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured with suitable adhesives.

- G. Non-metallic raceway installation shall conform to the following:

1. All joints are to be made by the solvent cementing method using the material recommended by the raceway's manufacturer. To insure good joints, components shall be cleaned prior to assembly. Fittings, cement, and conduit shall be supplied by the same manufacturer.
 2. Raceway cut-offs shall be square and made by handsaw or other approved means which does not deform the conduit. Raceways shall be reamed prior to solvent cementing to couplings, adaptors, or fittings.
 3. Electrical devices which are served by PVC raceways shall be grounded by means of a ground wire pulled in the raceway.
 4. Male box adapters shall be used for all box or raceway fittings to terminate plastic raceways.
 5. Where separable terminations are required, they shall be made using PVC Threaded Adapters with lock-nuts or bushings. If such terminations must be water-tight, "O" rings shall be installed.
 6. Bends shall be made by methods that do not deform or damage the conduit. The radii of field bends shall not be less than those established by the N.E.C.
 7. Raceway expansion fittings shall be provided where necessary. The position of the expansion fitting shall be adjusted proportional to the temperature at installation.
 8. Raceway supports shall be installed, in such a manner, to allow the PVC Conduit to slide through the supports as the temperature changes.
 9. Elbows must be galvanized rigid steel or intermediate metallic conduit.
 10. Non-metallic raceway is not permitted to be installed within the building.
- H. Raceways in hung ceiling shall be run on and secured to slab or primary structural members of ceiling, not to lathing channels or T-bars, Z-bars, or other elements which are the direct supports of the ceiling panels. Secure conduit firmly to steel by clips and fittings designed for that purpose. Install as high as possible, but not less than 1'-0" above hung ceilings.
- I. Conduit above accessible ceilings and exposed raceways shall be run parallel or at right angles with building lines. Secure raceway clamps or supports to masonry materials by toggle bolts, expansion bolts, or steel inserts. Install raceways on steel construction with approved clamps which do not depend on friction or set screw pressure alone.
- J. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. This shall be done with a ball mandrel (diameter approximately 85% of conduit inside diameter) followed by a close fitting wire brush and wad of felt, or similar material. This assembly may be pulled in together with, but ahead of, the cable being installed. All empty raceways shall be similarly cleaned. Clear any raceway which rejects ball mandrel.
- K. Support less than two (2") inches trade size, vertically run, raceways at intervals no greater than eight (8) feet. Support such raceways, two (2") inches trade size or larger and made up with threaded couplings, at intervals no greater than the story height, or fifteen (15) feet, whichever is smaller.
- L. Support less than (1") inch trade size, horizontally run, raceways at intervals no greater than seven (7) feet. Support such raceways, one (1") inch trade size or larger, at intervals no greater than ten (10) feet.

3.3 WIREWAYS AND AUXILIARY GUTTER

- A. Wireways installed in hung ceilings shall be placed such that the cover will hinge upward from the side.
- B. Twelve (12") inches clear shall be provided from wireway cover when it is in the open position.
- C. Routing of wireways, shown on plans, is diagrammatic. Provide a complete system including corners, elbows, and angle sections to clear the work of other trades and other obstructions.

3.4 OUTLET, JUNCTION, AND PULLBOXES

- A. Provide outlet, junction, and pullboxes as indicated on the drawings and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of wires and cables. J-boxes and pullboxes shall be sized per electrical code minimum. Boxes on empty conduit systems shall be sized as if containing conductors of #4 AWG.
- B. The exact location of outlets and equipment is governed by structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels, equipment, etc., with Architect.
- C. Back-to-back outlets in the same wall, or "thru-wall" type boxes, are not permitted. Provide twelve (12") inch (minimum) spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.
- D. Fit outlet boxes in finished ceiling or walls with appropriate covers, set flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide Series "GW" (Steel City) tile box, or as accepted, or a four (4") inch square box with tile ring in masonry walls, which will not be plastered or furred. Where drywall materials are utilized, provide plaster ring. Provide outlet boxes of the type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in same box, provide suitable barrier.

- E. Types of Boxes and Fittings for Various Locations

Locations	Types
Outlet	Galvanized pressed steel
Outlet exposed to moisture and outdoors	Cast type conduit fitting
Splice	Galvanized press steel

- F. Pull Box Spacing

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360 degrees total).
2. Conduit Sizes 1-1/4" and larger.
 - a. Provide boxes to prevent cable or wire from being excessively twisted, stretched, or flexed during installation.
 - b. Provide boxes for medium voltage cables so that maximum pulling tensions do not exceed cable manufacturer's recommendations.
 - c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside box.
3. Conduit sizes one (1") inch and smaller, low voltage wire and cable (maximum distances).
 - a. 150 feet straight runs.
 - b. 100 feet runs with one 90 degree bend or equivalent.
 - c. 75 feet runs with two 90 degree bends or equivalent.
 - d. 50 feet runs with three or four 90 degree bends or equivalent.

G. Sheet Steel Boxes

1. Size and shape (if not on drawings) to avoid exceeding manufacturer's minimum bending radius recommendations for conductors.
2. Access for removal and replacement of conductors, splices, and equipment.
3. Minimum dimensions of boxes in runs of 1-1/2" or larger conduit.
 - a. Straight Pulls
 - 1) Sizes length eight (8) times nominal diameter of largest conduit.
 - b. Angle or U Pulls
 - 1) Size such that distance between conduit entry and opposite wall of box is six (6) times nominal diameter of largest conduit.
4. Covers
 - a. Fasten to flange or framework of box with machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required.

H. Identification labels for all low voltage and medium voltage pull, splice and junction boxes in main feeder and subfeeder runs, indicating nominal system voltage.

1. Apply labels after painting of boxes, conduits, and surrounding areas have been completed.
2. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.
3. Apply labels on cover and minimum of one (1) fixed side: one (1) label viable from floor where boxes are installed exposed.

3.5 SLEEVES

- A. Where sleeves are required for the installation of electrical work, passing through walls or floors, they shall be furnished and installed under this Section of the specification unless indicated otherwise on the drawings. Such sleeves shall be galvanized or black enameled rigid steel conduit or Schedule 40 black steel pipe. Aluminum conduit sleeves shall not be used. Where specific sizes are not indicated on the drawings, sleeves shall be sized to provide 1/2 inch clearance around the outside surface of the item for which they are installed. They shall be cut flush with wall surfaces and shall extend two (2") inches above finished floor level, or as indicated on the drawings.
- B. For interior walls and for floors, the space between conduit, ground cable, or similar items and sleeves shall be packed to the full depth of wall or slab thickness with one of the following:

Material	Manufacturer
All-Purpose Insulating Cement	McMasters-Carr Supply Company
Vermiculite (Plaster Mix)	Vermiculite Products, Inc. Houston, TX 77000 Vermiculite-Intermountain, Inc. 333 West – 100 South Salt Lake City, UT
Perlite (Plaster Mix)	Perlite Manufacturing Company Carnegie, PA 15106 Zonolite Construction Products – Division of W.R. Grace & Company 62 Witamore Avenue Cambridge, MA

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide fixed identification of all distribution equipment and conductors in accordance with the Contract Documents.
- B. Related work in other sections:
 - 1. Section 26 05 21 – Wires and Cables
 - 2. Section 26 24 13 – Switchboards
 - 3. Section 26 24 16 – Panelboards
 - 4. Section 26 28 23 – Disconnect Switches – Fused and Non-Fused
 - 5. Section 26 51 00 – Interior Lighting

1.2 REFERENCES

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Industry standards shall apply.

1.3 SUBMITTALS

- A. Identification procedures shall be noted and scheduled on the applicable shop drawings.

PART 2 - PRODUCTS

- 2.1 Unless otherwise noted, nameplates shall be black lamacoid plates with white engraved upper case letters enclosed by white border on beveled edge.
- 2.2 Nameplates for equipment, supplied by the emergency system, shall be red lamacoid with white lettering.
- 2.3 All nameplates must be engraved and must be secured with rivets, brass or cadmium plate screws. The use of Dymo tape or the like is unacceptable.

2.4 Lettering heights unless otherwise noted must be as follows:

Item	Lettering Height
Switchboards	2"
Panelboards and Load Centers	1/2"
Feeder Switches	1/4"
Remote Smoke Detector Lamps	1/8"
Wall Plates	1/8"

2.5 Cable tags must be flameproof secured with flameproof non-metallic cord.

2.6 Nameplate inscriptions must bear the name and number of equipment to which they are attached as indicated on the Drawings. The engineer reserves the right to make modifications in the inscriptions as necessary.

2.7 The Engineer reserves the right to request additional nameplates at time of review of shop drawings and upon site observations. These shall be furnished at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switchboards

1. Furnish and install a master nameplate for each switchboard engraved with the equipment identification indicated on the Drawing. Mount at top of incoming section.
2. Provide on each main switch an identifying nameplate. Where multiple mains are employed each switch shall be numbered. Inscription shall be "main switch" or "main switch no 1" et al.

B. Panelboards and Load Centers

1. Furnish and install a nameplate for each panelboard and load center engraved with the identification indicated on the Drawings. Mount at top of panel.
2. After installations are complete, provide and mount under sturdy transparent shield in the directory frame of each panel door, a neat, accurate, and carefully typed directory properly identifying the lighting, receptacles, outlets and equipment each overcurrent device controls.
3. Include on directory the panel or load center identification, the cable and raceway size of panel feeder, and the feeder origination point.

C. Disconnect Switches

1. Furnish and install a nameplate for each disconnect switch engraved with the equipment designation which the disconnect serves.

D. Feeder Switches

1. Furnish and install for each feeder switch two (2) nameplates as follows:
 - a. The first nameplate must be white background with red lettering. Engrave with the words "REPLACE ONLY WITH _____ FUSE." Engrave with proper fuse trade name and ampere rating (i.e. Bussman LPS-R 100).
 - b. The second nameplate shall indicate the load served, the size and type of cable and raceway example:
 - 1) LP-4, LP-5, LP-6
 - 2) 4#500 MCM-THW-CU-3-1/2"C

E. Remote Smoke Detector Lamps and Test Stations

1. Furnish and install a nameplate on each remote smoke detector lamp and/or test station. Engraving must indicate the location of the device to which the lamp is connected, as approved by the Engineer.

F. Switches

1. Furnish and install an engraved nameplate for each switch, controlling loads which are not local to the switch. Engraving shall be as directed by the Engineer.

G. Pullboxes, Enclosures and Cable Terminations

1. Furnish and install cable tags on each cable, which enters a pullbox, enclosure, switchboard, and at terminations. Mark tags with type written inscription noting the load served, type and size of cable, and the overcurrent device protecting the cable.

H. High Voltage Raceways (over 600 volts)

1. Furnish and install on each high voltage raceway and following as conditions permit:
 - a. Exposed
 - 1) Self-adhesive labels on each raceway at every floor level and not more than 25'-0" on center. Labels are to be of a conspicuous color and note the operating voltage of the conductors so enclosed.
 - b. Concealed below grade or concrete
 - 1) Concrete insert type markers above each raceway at every floor level and not less than 25'-0" on center. Inserts are to be four (4") inches in diameter of nonferrous metal fit flush with finished surface. Inscription to state size of raceway and cable operating voltage and date of installation.

I. Luminaires

1. Where connected to other than 120-volt circuit, provide each fluorescent or high intensity discharge fixture with the ballast voltage stenciled on the ballast cover in letters not less than 1/2 inch high.

J. Painting and Finishing

1. All electrical fitting, supports, hanger rods, pullboxes, channel frames, conduit racks, outlet boxes, brackets clamps, etc., shall be galvanized finished or have enamel paint finish over corrosion-resistant primer.
2. All panelboards, distribution centers, etc., shall be factory finished in alkyd high gloss enamel applied over corrosion-resistant primer. Matte or flat type finish paint not acceptable. Factory finished units that are scratched or marked during installation shipping shall be touched up with matching spray-on air dry lacquer or, if required, to provide a satisfactory job, shall be completely refinished.
3. Fire alarm pullboxes and junction boxes to be finished in red.

END OF SECTION 26 05 53

SECTION 26 07 00 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 GENERAL

- A. The work of this section includes furnishing of all labor, tools, materials, and equipment necessary to complete all the demolition required for the project as specified herein and shown on the drawings.
- B. Cooperation with contractors under separate contracts is required, and the work described herein and shown on the drawings shall be coordinated as required to fulfill the intent of the contract.

1.2 INTENT

- A. It is the intent of this specification and accompanying drawings to describe and indicate the demolition work to be performed. It is not intended that the specifications and drawings describe and indicate every piece of equipment required to be removed for where items are intended to be removed or as required for the satisfactory completion of the project or is considered to be the accepted practice of the trade, they shall be considered to be specified and indicated.
- B. The contractor shall disconnect and remove all lighting fixtures, conduit, wire and related electrical items as indicated on the drawings, or as required by the project. This includes all abandoned low voltage signal and communication cables.
- C. The contractor shall seal floor, wall and ceiling openings with thermo setting fire resistive compound after removal of conduits.
- D. The contractor is cautioned that when performing demolition work circuitry servicing areas of the building outside the work area must remain in operation. The contractor is responsible, at his own expense, to repair any services or damages caused by his demolition work.
- E. When disconnecting equipment from existing circuits, if equipment is connected to the circuit which must remain active, the circuit continuity shall be maintained as required. Wiring from circuits becoming completely inactive shall be removed back to the source of supply.

PART 2 - SCOPE OF WORK

2.1 DEMOLITION/ALTERATION

- A. Prior to start of demolition, check to determine that power, communication services, etc., such as electricity and telephone, have been disconnected at the source of supply.

- B. The Contractor shall furnish and erect barriers, and maintain approved danger, warning, and "Keep Out" signs at locations where the placing of such signs is warranted for safety of all personnel not working in this area.
- C. Demolition shall be performed in such a manner as to avoid hazards to persons and property, interference with the use of adjacent properties, and interruption of free passage to and from such property. Work shall be performed in strict accordance with all Municipal, State and Federal Rules, Regulations, Codes, and Laws which may govern and apply to this work.
- D. During the demolition work in the effected areas, the building non-work areas must be protected from dust, dirt and possible water damage, to the Owner's satisfaction.
- E. All areas shall be cleaned and free of all debris resulting from the demolition work on a daily basis.
- F. Remove all equipment shown to be removed; however, all changes cannot be detailed completely on the drawings, some removals and relocations of existing electric work will be necessary for satisfactory performance of this and other trades. Take into consideration in proposal all required changes.
- G. Maintain continuous service on feeders, circuits or partial circuits, and outlets affected by this work, except where Architect gives written permission for outage for specified time. All work requiring shut down of existing systems shall be performed on overtime at hours as approved by the Architect and at no additional cost to the Owner. Submit schedule of required outages to the Owner for approval. Perform work in a manner to minimize shutdown time.
- H. Provide reconnections and temporary installations as required; remove at job completion.
- I. Take possession and remove from the premises all abandoned materials and equipment unless specified as returnable to the Owner; in which case, remove without damage all such equipment and turn over and deliver to Owner at location designated by the Owner.
- J. Cut back to floor, wall, or ceiling and plug ends of concealed conduits made obsolete by alterations to permit refinishing surfaces. Remove exposed conduits, wireways, outlet boxes, hangers and devices made obsolete by this work unless designated specifically to remain.
- K. Existing concealed conduits not interfering with the work of this or any other trade may remain; however, wiring shall be removed from panelboards or source of power and ends taped. No unused live wiring shall be left in place.
- L. Provide blank plates on all unused outlet boxes.
- M. Wherever extensions of wires or cables are shown on the drawings, check and verify wire and cable sizes and capacities. Secure Architect's acceptance of this data before new cables are ordered or installation started.

PART 3 - SALVAGE

3.1 SALVAGE

- A. The contractor shall be responsible for all damage to existing materials not affected by the demolition work. The contractor shall repair or replace damaged material or equipment as directed at no additional cost to the owner. Repairing and patching of areas shall be done by the respective trade involved with the demolition, utilizing workmen skilled in the trade involved with the repair or replacement of the material in question.
- B. All equipment, removed during demolition shall remain on the site, unless otherwise noted. The Owner reserves all rights to claiming material removed during demolition. The contractor is responsible to remove from the site all material not claimed by the Owner. In addition, the contractor is responsible to deliver to the Owner's storage facilities, equipment claimed by the Owner.

END OF SECTION 26 07 00

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General – provide panelboards in accordance with the Contract Documents.
- B. Related Work Specified in Division 26
 - 1. Section 26 05 26 – Grounding and Bonding
 - 2. Section 26 05 53 – Identification for Electrical Systems
 - 3. Section 26 28 14 – Fuses – Low Voltage
- C. Related Work Specified in other Divisions of these Specifications.
 - 1. Finish Painting

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and recommendations of the following:
 - 1. Panelboards
 - a. U.L. Standards #50 & #67
 - b. Federal Standard W-P-115A Type II, Class I and W-C-375B
 - c. NEMA Standard PB-1-1971
 - 2. Circuit Breakers
 - a. U.L. Standard #489
 - b. Federal Standard W-C-375A Amendment No. 4
 - c. NEMA Standard AB-1-1969

1.3 SUBMITTALS

- A. Refer to Section 26 05 05 concerning the procedures and additional documents for submittals in concert with panelboard submittals. Submittals failing to meet the following criteria will be returned without a review or acceptance.
- B. With each panelboard drawing the following is required:
 - 1. Show main devices and lug sizes; branch circuit device sizes and arrangement; bus ampacities; withstandability and short circuit rating; dimensions and construction; gutter

and backbox dimensions; nameplate and legend; protective coating; and all pertinent details of panel, enclosure, cover, and method of securing cover and lock.

1.4 QUALITY ASSURANCE

- A. Each panelboard as a complete and finished product shall receive a single integrated equipment rating by the manufacturer. The integrated equipment short circuit wiring shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value specified on the Drawings. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed to each panelboard. Test data shall be submitted to the Engineer at time of submission of Acceptance Drawings.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. All panelboards are to be of the same manufacturer as the switchboards.

2.2 PANELBOARDS IN GENERAL

- A. Provide panelboards consisting of an assembly of branch circuits switching and protective devices (circuit breakers) mounted inside a dead front enclosure. Provide the number and size of these branch circuit devices as indicated by the circuiting, on the drawings, and in the schedules. Locations of circuit breakers shall be as indicated in the schedules.
- B. Provide the following modifications and additional equipment as shown on the Drawings:
 - 1. Main circuit breakers
 - 2. Shunt trip circuit breakers
 - 3. Subfeed switches
 - 4. Feed through lugs and/or bus
 - 5. Feed through cabling arrangement
 - 6. Double lugs for multiple cables or for future provisions
 - 7. Ground fault interrupting circuit breakers
 - 8. Oversized gutters
 - 9. Door in door construction for power panels
- C. Interiors
 - 1. Rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.
 - 2. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units; without removing main bus or branch circuit connectors and without machining, drilling, or tapping in the field.

3. Arrange bus in sequence or distributed phasing so that multipole circuit breaker can replace any group of single circuit breakers of the same size.
4. Provide 200% neutral bus in each panelboard.
5. Provide ground bus in each panelboard.

D. Enclosure

1. Code gauge steel box galvanized
2. Provide a bolt-on ground connector to inside of enclosure.
3. Flush mounted in finished areas and where indicated. Surface mount elsewhere.

E. Front

1. Doors must be provided on all lighting and power panels.
2. Heavy code gauge steel as required to maintain panel face flat.
3. Hold front closed with trim clamps.
4. Factory finished in medium gray enamel or two coats of air-drying lacquer over a rust inhibitor.
5. Provide directory for total number of poles.
6. Provide approved lock. All panels keyed alike. Furnish four (4) sets matching keys to the Owner.
7. Welded angle rest at the bottom of the door to facilitate cover installation.
8. Door over 48" in height shall have auxiliary fasteners at top and bottom of door in addition to lock and catch.

F. Multiple Section Panelboards

1. Each section of multiple section panelboards shall be the same height.
2. Multiple sections shall each contain the same number of poles (e.g. 84 poles equal 2-42 pole panels).

G. Terminal Lugs

1. Bolted type, labeled for either copper or aluminum conductors.
2. Locate main lugs properly at top or bottom, depending where main feeder enters.

H. Electrical Ratings

1. Panelboards are to be rated 120/208 volts, three (3) -phase, Four (4) wire, 200% neutral with ampacities as indicated on the Drawings (unless otherwise noted).
2. Short circuit withstand ratings shall be as indicated on the Drawings or by the Fault Current and Coordination Study where a new switchboard is provided.
3. Where indicated, provide panelboards having a "service entrance" Type UL label with neutrals factory bonded to frame or enclosure.

I. Circuit Breaker Devices

1. Plastic molded case bolt-on type. Plug-on or plug-in type breakers are unacceptable. Completely sealed enclosure. Toggle type operating handle. Trip ampere rating and ON/OFF indication clearly visible.

2. Thermal-magnetic trip-free, trip-indicating, quick-make, quick-break, with inverse time delay characteristics. Single handle and common tripping multipole breakers.
3. Silver alloy contacts with auxiliary arc-quenching devices.
4. Panelboard must be of the type which will accept the field installation of shunt trip devices of 60 amperes or less on the branch devices.
5. Interrupting capacities shall be "fully rated" with AIC ratings as indicated on the Drawings or as indicated in the Fault Current and Coordination Study. As a minimum, 120/208 volt devices shall be not less than 10,000 AIC and 277/480 not less than 14,000 AIC.
6. For lighting circuits provide devices labeled "SWD" for switching purposes.
7. Bolted type terminals U.L. listed for either aluminum or copper 75 degrees C cables.
8. Provide main breakers in panels served from transformers unless separate transformer secondary protection is provided.
9. Locate next to each breaker or space unit an individual number.
10. Circuit breakers serving elevators, computer equipment and those serving kitchen equipment beneath cooking hoods shall include a shunt trip coil.
11. Shunt trip breakers shall be supplied with 120 volt coils. Provide 120 volt circuit from nearest 120 volt panel to coil. Where shunt trip breakers are in emergency panels provide emergency 120 volt source for same from nearest 120 volt emergency panel.
12. Provide locking device for designated breakers.
13. For HVAC equipment, provide UL listed: HACR type devices.

J. Ground Fault Interrupters

1. Ground fault interrupter branch circuit breakers shall be as indicated on the Drawings. Circuit breakers shall be circuit interrupting which will operate manually for normal switching functions and automatically under overload, short circuit, and 0.005 amp line-to-ground fault conditions. The operating mechanism shall be entirely trip-free so that contact cannot be held close against an abnormal overcurrent, short circuit, or ground fault condition. The device shall be bolt-on type with case construction and shall be interchangeable with standard 1P breakers utilized in the panelboard.

K. Future Devices

1. Any space within breaker mounting area where a breaker may be mounted, shall be bussed and fully equipped to accept a breaker without any further modifications to the panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount all panels at a maximum height of 6 feet 6 inches to top unless otherwise noted.
- B. Mount surface type panels a minimum one (1) inch off wall on channels.
- C. Where flushed mounted, the fire integrity of the wall in which it is installed must be maintained.

- D. Neatly arrange branch circuit wires and tie together in each gutter with Thomas & Betts nylon "Ty-Raps", or approved equal at minimum (4) four inch intervals.
- E. Plug all knockouts removed and not utilized.
- F. Provide nameplate and fill out panel directory per Section 26 05 53.
- G. Provide grounding and bonding jumpers per Section 26 05 26 and as indicated on the Drawings.

3.2 TOUCH UP AND CLEANING

- A. Vacuum all backboxes clean of debris after installation and prior to final payment.
- B. Touch up scratch marks, etc. with matching paint.

3.3 OBSERVATIONS

- A. All panel fronts shall be removed by the Contractor for observation of the panel interiors by the Engineers.
- B. Panel fronts shall be removed when directed by the Engineer/Architect for observation (either by floor, or by group of floors on all panels on the project as required by the Engineer/Architect) and reinstalled immediately thereafter the observations.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide wiring devices in accordance with the Contract Documents.
- B. Related Work Specified in other Divisions of these Specifications.
 - 1. Finish painting.
- C. Color: Confirm the color of devices and plates with the Owner/Architect prior to submitting shop drawings or ordering any materials.

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Switches
 - a. Federal Specifications Standard WS-896E.
 - 2. Receptacles
 - a. N.E.M.A. Standard WD-1, 3.2 through 3.10.
 - b. U.L. Standard 498 Federal Specification WC596-D.
 - c. ANSI.

1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts and specifications for all wiring devices and plates.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. The manufacturers listed below as well as Arrow-Hart, General Electric, Slater & Leviton are acceptable. All devices shall be of the same manufacturer.

B. Switches

1. Hubbell – HBL 1220 Series (color white in finished areas, Ivory in utility rooms, shops maintenance areas, etc.)

C. Duplex Convenience Receptacles

1. Hubbell – HBL5362 (color white – in finished areas, black in utility rooms, shops, maintenance areas, etc.).
2. Arrow-Hart – equal.
3. Pass & Seymour – equal.

D. Faceplates

1. Type 302 Stainless Steel device manufacturer.

E. Ground Fault Circuit Interrupters

1. Provide GFCI receptacle in cast aluminum box with weatherproof, gasketed, spring loaded in-use cover complying with NEC Article 406.8(B) wet locations.

F. Outdoor Receptacles

1. Hubbell – GF5362 (color black – in unfinished areas.)

G. Tamperproof Receptacles

1. Hubbell – HBL8300 GA series (color white)

2.2 SWITCHES

- A. Provide heavy duty specification grade, flush mounting, quite-operating AC type, with toggle operator, heat-resistant plastic housing and self grounding metal strap. Silver alloy contact. Rated 20A at 120-277V. Design for side or back wiring with up to Number 10 wire. Verified by UL to meet or exceed Federal specification WS-896E.
- B. Use single-pole, double-pole, 3-way, 4-way, pilot or keyed type, as indicated on drawings or required.

2.3 DUPLEX CONVENIENCE RECEPTACLES

- A. Provide 2-pole, 3 wire, NEMA and ANSI heavy duty, grounding type, with bronze contacts that accept plug with 2 parallel blades and 1 grounding blade. Heat-resistant thermoplastic enclosure with nylon face. Two grounding screws. Break-off terminals for 2-circuit wiring. Rated 20 amperes at 125-volt electrical alternating current.

2.4 FACEPLATES

- A. Provide cover plates for wall receptacles, outlets, and switches of 302 stainless steel with satin finish, unless otherwise noted. When two or more switches or devices are shown in one location, mount under a common plate.

2.5 OUTDOOR LOCATIONS

- A. Each receptacle installed in a damp or wet location shall be corrosion resistant having all metal parts from stainless steel or be nickel plated brass.
- B. Protect exterior switches and those in mechanical room which act as plenums by a cast aluminum metal plate with a fiber shield and spring loaded cover.
- C. Protect exterior receptacles and receptacles in wet locations by a cast aluminum metal plate with a clear plastic, spring loaded cover that is weatherproof whether or not the attachment plug cap is inserted.
- D. All switches located outside shall be provided with weatherproof cover.

2.6 GROUND FAULT CIRCUIT INTERRUPTERS

- A. Where indicated or required provide ground fault circuit interrupters which will interrupt leakage currents between 4-6 M.A. having a maximum circuit current of 20 amperes. Employ feed through or non-feed through devices as indicated, or required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise required by ADA or indicated in Section 260500.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Recommendation in subparagraph below is made in IEEE 602.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION 26 27 26

SECTION 26 28 14 - FUSES-LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. General

1. Provide fuses in accordance with the Contract Documents.

B. Related Work in Specification Division 26

1. Section 26 24 13 – Switchboards
2. Section 26 24 16 – Panelboards
3. Section 26 28 23 – Disconnect Switches – Fused and Non-Fused

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. UL Standard #198
2. UL Standard #977

1.3 SUBMITTALS

A. Provide a complete set of shop drawings to include let-through curves for each type of fuse.

B. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.

C. Submit listing of all spare fuses by types, sizes and quantities, which will be furnished for placement in the respective fuse cabinets.

D. Submit dimensioned drawings of each fuse cabinet by type and size.

E. Short circuit current analysis is based upon Bussman fuse characteristics for let-through currents. If Reliance, Cefco or Gould-Shawmut fuses are to be utilized, it is the Electrical Contractor's responsibility to provide the appropriate fuse curves and let-through values which correspond to the Bussman values shown on the Drawings. Submit comparative chart of fuse substitutions for Architect/Engineer and for respective Building Department review prior to acceptance of same substitutions. Comparative chart shall include the following:

1. Cross reference of fuses to be used in place of Bussman fuse type designation indicated on the drawings or specified herein.

- F. Submit proof of coordination with the power company for any fuses associated with electric service.
- G. Fuses shall comply with the recommendations of the Fault Current and Coordination Study.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Fuses
 - 1. Bussman
 - 2. Cefco
 - 3. Gould-Shawmut
 - 4. Reliance

- B. Spare Fuse Cabinet
 - 1. By fuse supplier.

2.2 MATERIALS

- A. Mains, Feeders, and Branch Circuits
 - 1. General
 - a. All fuses shall be labeled as UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Time delay Class R fuses shall be so labeled.
 - 2. Main Service and All Feeder-Circuits
 - a. Fuses over 600 amperes shall be UL Class L. Fuses up to 600A shall be UL class RK1 labeled Time-delay.
 - 3. Branch Circuits
 - a. Unless noted otherwise on the drawings, all fuses up to 600A shall be UL Class RK5 labeled Time-delay.
 - 4. All fuses shall be so selected as to provide a selectively coordinated system.
 - 5. All fuses shall be of the same manufacturer.
- B. Spares
 - 1. Upon completion of the building, the contractor shall provide the Owner with spare fuses as indicated below:

- a. 10 percent (minimum of 3) of each type and rating of installed fuses shall be supplied as spare.
- b. Spare fuse cabinets shall be provided to store the above spares.
- c. Spare fuse cabinets shall be provided as a minimum in the following locations.
 - 1) Each main switchgear room.
 - 2) Each major mechanical equipment room.

C. Labels

1. Paste-on labels for building standard fuses of 600A and below to read:

EXAMPLE:

"WARNING: INSTALL CLASS RK1 FUSES ONLY."

D. Coordination

1. All fuses associated with electric service shall be coordinated with the power company prior to ordering any fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fuses shall not be installed until equipment is ready to be energized. Verify the proper fuse size before ordering, regardless of sizes shown on drawings.
- B. Provide and install fuses of proper type, voltage and ampere ratings for all fusible devices furnished under this section and all other sections of this specification.
- C. Labels
 1. Paste appropriate label within each switch, motor starter, or panelboard door or at location next to fuse clips, where fuses shall be furnished and installed by this Contractor. Fill-in, in ink blank spaces on labels for non-standard fuses with appropriate fuse data.

END OF SECTION 26 28 14

SECTION 26 28 23 - DISCONNECT SWITCHES - FUSED AND NON-FUSED

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide fused and unfused disconnect switches in accordance with Contract Documents.
- B. Related Work Specified in Division 26
 - 1. Section 26 28 14 – Fuses – Low Voltage
 - 2. Section 26 05 26 – Grounding and Bonding
 - 3. Section 26 05 53 – Identification for Electrical Systems
- C. Related Work Specified in other Divisions of these Specifications.
 - 1. Setting of motors and other equipment.

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and the latest applicable recommendations of the following:
 - 1. U.L. Standards #98 (File #4776) and #508.
 - 2. Federal Specifications W-S-865C.
 - 3. NEMA Standard KS1-1975.
 - 4. U.L. 20 and Federal Specification Test Standards for Toggle Switches.

1.3 SUBMITTALS

- A. Submit manufacturer's data for all disconnect switches.
- B. Identify motor or equipment served by each switch; indicate nameplate inscription.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Safety switches.
 - 1. Shall be of the same manufacturer as the <switchboard> <panelboards> <other>.

- B. Toggle type manual control switches.
 - 1. Square D Class 2510, 11, 12.
 - 2. Siemens Class SMF
 - 3. General Electric Type RB with enclosure.

2.2 SAFETY SWITCHES

- A. Heavy-duty, horsepower rated, single-throw knife switch with quick-make, quick-break mechanism, capable of full load operations. Meet NEMA and U.S. Government specifications for Class A switches.
- B. Provide with contact arc-quenching devices, such as magnetic blowouts or snuffing plates. Provide self-aligning switchblades with silver alloy contact areas and designed so that arcing upon making and breaking does not occur on the final contact surfaces. Provide with high-pressure, spring-loaded contact. Mount switch parts on high-grade insulating base.
- C. Enclosure – NEMA 1 with hinged door and defeatable interlock when switch is in "ON" position and can be positively padlocked in "ON" and "OFF" positions. Utilize NEMA 3R (rain-tight) enclosure for exterior installations.
- D. Size, fusing and number of poles as shown or as required. Where fused, the devices must be provided with UL listed rejection feature to reject all but Class R fuses. Provide horsepower rated switch to match motor load if no size is shown. Use 3 pole plus solid neutral switches on four wire circuits and 3 pole switches on all other circuits, unless otherwise noted.
- E. Lugs must be UL listed for aluminum and/or copper conductors and be front removable.
- F. Provide six (6) pole switches for connection to motors with the following starter types:
 - 1. Non-reversing – two-step – part winding – star connected.
 - 2. Non-reversing – full voltage – two speed separate winding.
 - 3. Non-reversing – full voltage – two speed single winding.
 - 4. Where otherwise required.
 - 5. Provide auxiliary contacts for switches where required or where indicated on the drawings.

2.3 TOGGLE TYPE MANUAL CONTROL SWITCHES

- A. Provide switches that operate at their full rating with fluorescent, tungsten and resistance loads, and at 80% of their rated capacity with motor loads.
- B. Switches to be heavy duty and have:
 - 1. Arc-resisting bodies.
 - 2. Slow make-and-break mechanisms
 - 3. Silver alloy contact buttons
 - 4. Side or back wiring with up to No. 10 AWG solid conductors

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Each motor over 1/2 HP shall be provided with a horsepower-rated safety-type disconnect switch.
- B. Each piece of equipment utilizing multi-phase power shall be supplied with a safety-type disconnect switch.
- C. Each piece of equipment utilizing single-phase power but protected at over 30 amperes shall be supplied with a safety-type disconnect switch.
- D. Equipment other than that mentioned above may utilize a toggle type manual control switch properly sized and rated for the equipment it disconnects.
- E. Factory installed disconnect switches may be used to satisfy the above requirements with the Architect/Engineer's prior approval.

3.2 MOUNTING

- A. Provide connections and wiring to and from each disconnect switch. Support conduit feeder from ceiling or floor.
- B. Disconnect switches shall be mounted at adjacent wall or from the floor with independent supports. Switches shall not be mounted on fan housings.
- C. Mount switch enclosure rigidly and with proper alignment on building structure or steel supports with centerline of operating handle not more than 6 feet above finished floor unless otherwise required. Use steel supports fabricated from standard rolled structural steel shapes or framing channel to provide one-inch separation between enclosure and building wall for vertical flow of air.
- D. Install fuses as specified in Section 26 28 14.
- E. Completed installation shall contain no extraneous openings.

3.3 IDENTIFICATION

- A. Provide identification of all disconnect switches in accordance with Section 26 05 53 of these specifications.

END OF SECTION 26 28 23

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide luminaires and accessories in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 260510 – Testing, Inspection and Certification
2. Section 260514 – Equipment Connections and Coordination
3. Section 260521 – Wires and Cables
4. Section 260529 – Hangers and Supports for Electrical Systems
5. Section 260533 – Raceways and Boxes
6. Section 260553 – Identification for Electrical Systems
7. Section 262726 – Wiring Devices

C. Related Work Specified in Other Divisions of these Specifications.

1. F.F. & E. Package
2. Concrete Bases
3. Duct and Duct Accessories

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Luminaires – UL 57, UL 1570, UL 1571, UL 1572, UL 676.
2. Exit and Egress Luminaires – NFPA 70 and 101, UL 924.
3. Lamp Holders and Starters – UL 496, UL 542, UL 879.
4. Hazardous Locations – UL 1225, UL 1203, UL 506, UL 844, UL 886.
5. Cords – UL 62.
6. IES-SPI-NEMA Joint Standards for Class A and Class C acrylic compounds for plastic enclosures.
7. L.E.D. Light Sources – UL 8750-09
8. Local code requirements.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturers' data for the following items in accordance with the conditions of the contract and as specified below.

1. Major luminaires and special luminaires shall show full-size cross sections. Indicate finished dimensions, metal thicknesses, and materials.

2. Show mounting details, including hung ceiling construction.
3. Shop drawings shall include a complete listing of all luminaires on a single sheet. This listing shall contain the luminaire type, manufacturers catalog number, applied voltage and luminaire quantities.
4. The Owner reserves the right to require submittal of a complete sample fixture for any fixture type.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Luminaires

1. Manufacturers and catalog numbers used for basis of design are listed in the lighting fixture schedule shown on the Drawings.
2. Fixtures submitted shall be as per specified in the lighting fixture schedule as shown on the Drawings. Substitutions to specified fixtures may be submitted for approval if the substitution meets the minimum lamp performance and design criteria as described in the fixture schedule. All substitutions shall be made to the construction manager or engineer 10 days prior to bid due date for approval.
3. The designations indicated on the lighting fixture schedule are a design series reference (not necessarily a complete catalog number) and do not necessarily represent the number, size, voltage, wattage, type of lamp, finish trim, ceiling type, mounting hardware or special requirements as specified hereinafter on as required by the particular installation(s) and code. Contractor shall verify these requirements and order fixtures as required to give proper installation per the contract documents and per code.

2.2 FIXTURE QUALITY AND DESCRIPTION

- #### A. Manufacture luminaires to the specifications described herein and on the drawings.

2.3 FABRICATION

- #### A. Provide luminaires, completely factory-assembled and wired and equipped with necessary LED drivers, wiring, shielding, reflectors, channels, lenses, etc., and deliver to job ready for installation.

2.4 MATERIALS

A. Plastic Lenses and Diffusers:

1. Virgin methyl methacrylate unless otherwise noted. De-staticize after cleaning. Install and leave with no finger prints or dirt marks on the lens or diffuser. Use white gloves if necessary.
2. Minimum nominal thickness for flat acrylic lens: .156 inch unless otherwise specified in the Fixture Schedule on the drawings.

- B. Finish: Porcelain or baked enamel finish, matte white on interiors with minimum tested reflectance of 90 percent. Matte white finish or as specified for visible portions of exterior. Thoroughly clean base metal and bonderize after fabrication.
- C. Luminaire Wiring: Minimum individual luminaire wiring – number 18 gauge with insulation at rated operating temperature of 105 degrees Centigrade or higher. Terminate wiring for recessed luminaires, except fluorescent units, in an external splice box.

2.5 LED LIGHT FIXTURES

A. General:

- 1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
- 2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) – compliant.
- 3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C. (-4°F)
 - c. Input Voltage: 120-277V (+/-10%) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: ≥ 0.95
 - f. Total Harmonic Distortion: $\leq 20\%$
 - g. Comply with FCC 47 CFR Part 15
- 4. LED modules shall include the following features unless otherwise indicated:
 - a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

- 1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:

- 1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
- 2. Housing, LED driver, and LED module shall be products of the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Architect's and/or interior designers reflected ceiling plans show actual location of luminaires. Report to the Architect/Engineer any conflict between these plans and the electrical documents. Perform the work in accordance with the Architects/Engineers instructions. At the time of bid, include the most stringent requirement.
- B. Spaces for luminaire insertion will be provided by the trade that installs the ceiling. Furnish plaster and other frames for setting and installing under another section of these specifications.
- C. Install luminaires in mechanical and unfinished areas after ductwork and piping installation. Locate fixtures 8 feet 6 inches above floor or at suitable locations within space on walls but not lower than 7'-0" AFF. Where mounted lower than 8'-6" luminaires shall be protected by an approved wire guard.
- D. The Contractor is required to protect luminaires from damage during installation of same and up to time to acceptance by the Architect/Engineer and any broken luminaires, glassware, plastics, lamps, etc., must be replaced by the contractor with new parts, without any additional expense to the Owner.
- E. Where luminaires are surface mounted, they shall be labeled for such and in minimum of one-half (1/2) inch air space shall be maintained between top of luminaire and mounting surface by an approved means.
- F. Pendant mounted units shall comply with the following:
 - 1. Where 8' and 4' luminaires are mounted in a continuous row, luminaires, eight feet in length, shall have stems placed within 2'-0" apart. Stems shall be spaced symmetrically with a minimum of two (2) stems per eight foot fixture and one (1) stem per four foot fixtures so as to provide a uniform appearance throughout.
 - 2. Individual luminaires, four feet or three feet in length, shall have two stems placed approximately 3 inches from each end.
 - 3. Individual luminaires, eight feet in length shall have two stems placed approximately 4'-0" apart.
 - 4. Each stem shall have a brass or steel swivel or other self-aligning device. The entire luminaire mounting (hickey, aligner, swivel, stem, etc.) shall be approved and provided by the fixture manufacturer.
 - 5. A malleable iron bushing shall be placed at luminaire end of stem through which wire passes.
 - 6. A pendant support using an approved sliding clevis bracket which firmly grips an indentation in rigid sides of the wiring channel will be acceptable.
 - 7. Connections between outlet boxes and luminaires shall be by means of approved flexible raceways.
- G. Where luminaires are mounted upon surface-mounted outlet boxes in surface mounted conduit runs, this Contractor shall furnish and install a luminaire canopy sufficiently deep to permit exposed conduits to pass through. Canopy shall have proper openings cut by luminaire manufacturer through which conduits may pass. Submit sample of canopy for approval before installation.

- H. Where required by the local Building Department, provide approved wire guards over luminaires.
- I. Prior to final payment this contractor shall clean all luminaires and replace all expended lamps. He shall also touch up all scratch marks, etc. in an approved manner.
- J. Except as otherwise noted as a minimum procedure, support surface or pendant mounted luminaires:
 - 1. Where weight is less than five pounds, from its outlet box by means of an interposed metal strap.
 - 2. Where weight is from five to fifty pounds, from its outlet box by means of a hickey or other direct threaded connection.
 - 3. Whose weight exceeds fifty pounds, directly from structural slab, deck or framing member.
- K. Except as otherwise noted as a minimum procedure, support recessed luminaires:
 - 1. Where weight is eighty pounds or less ceiling suspension members, as described above.
 - 2. Where weight is more than eighty pounds directly from structural slabs, decks or framing members.
 - 3. Where luminaires and ceilings are such as to require luminaire support from ceiling opening frames, include in the electric work the members necessary to tie back the ceiling opening frames to ceiling suspension members or slabs so as to provide actual support for the luminaires as noted above.
- L. In conjunction with luminaires weighing less than fifty pounds the above restriction against supporting from suspended ceiling splines, runners or bars in the plane of the ceiling will be waived for ceilings which have been specifically approved for the weight and arrangement of luminaires being applied. Any support members, or other appurtenances, however, required to tie in or adapt the luminaires and their ceiling opening frames (if any) to the ceiling in the approved manner shall be included as part of the electric work.
- M. In stairwells provide at minimum a luminaire of the type specified at each landing and at each intermediate landing.
- N. Install exit lights as indicated on the drawings but not higher than 10'-0" AFF. All exit lights shall be installed with the downlight component fully operational.
- O. Track luminaires, adjustable luminaires, floodlights, and accent lights shall be aimed as directed by the Architect/Engineer. Outdoor lighting shall be aimed in periods of darkness.
- P. Recessed luminaires to be installed in metal pan or acoustic modular ceilings shall be modified as required to fit into openings in ceiling construction. This contractor shall coordinate and verify this work with the General Construction Contractor. Shop drawings showing details shall be submitted for approval.
- Q. Plumb all outdoor lighting standards to true vertical. For bolted poles, provide galvanized anchor bolts and nuts. Plumb using a nut above and below the base plate on the anchor bolts. Pack grout between base plate and concrete footing and provide drain hole below base plate to prevent accumulation of moisture inside pole base. Provide two piece or individual covers for

nuts exposed above the baseplate of the same color as the pole. Ground all metal lighting standards.

3.2 COORDINATION WITH MOUNTING CONDITIONS

- A. This contractor is responsible for coordinating the mounting accessories and luminaire trims with the ceiling conditions for which each luminaire will be installed. No extra compensation will be permitted for failure to coordinate.
- B. All luminaires in hung ceilings are to be installed with earthquake clips.

3.3 COORDINATION WITH AMBIENT CONDITIONS

- A. This contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions which will exist when the luminaires are installed. No extra compensation will be permitted for failure to coordinate the luminaires with their ambient conditions. These areas of coordination include but are not limited to the following:
 - 1. Wet location labels
 - 2. Damp location labels
 - 3. Plenums and air handling spaces
 - 4. Fire rated ceilings
 - 5. Low density ceilings
 - 6. Insulated ceilings

3.4 FINAL ADJUSTMENTS

- A. Adjust reflector/refractor position and aim fixtures as required.

END OF SECTION 26 51 00

SECTION 27 16 00 - TESTING AND IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 SCOPE OF WORK

- A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.
- B. Work specified in this section is included in the cabling contract.
- C. This section includes the minimum requirements for the testing, certification administration and identification of backbone and horizontal cabling, including:
 - 1. Tester Calibrations / Factory Requirements
 - 2. UTP testing and testers
 - 3. Labels and labeling
 - 4. Reports
 - 5. Documentation
 - 6. Record Copy and As-Builts
 - 7. Test Acceptance
 - 8. Warranty

1.3 REFERENCES

- A. The products and work herein specified shall comply with the current additions of the following publications and standards.
 - 1. UL - Underwriter Laboratory
 - 2. NEC – National Electric Code
 - a. Article 725
 - b. Article 770
 - c. Article 800
 - 3. NFPA – National Fire Protection Association
 - 4. NECA - Standard of Installation
 - 5. ANSI – American National Standards Institute
 - 6. NEMA – National Electrical Manufacturers Association

- a. Article 250
- 7. EIA – Electronic Industries Alliance
 - a. ANSI/EIA/TIA 568B.X
 - b. ANSI/EIA/TIA 569A
 - c. ANSI/EIA/TIA 606A
 - d. TIA/EIA-J-STD-037
- 8. TIA – Telecommunications Industry Association
- 9. IEEE C2 National Electrical Safety Code
- 10. FCC - Federal Communications Commission
 - a. CFR 68
- 11. BICSI – Building Industry Consulting Services International
 - a. Distribution Methods Manual
 - b. ANSK/NECA/BICSI 568
- 12. ISO/IEC 11801
- B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 QUALITY ASSURANCE

- A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.
- B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.
- C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.5 SUBMITTALS

- A. Provide manufactures cut sheets, specifications, and installation instructions for the products herein specified.
 - 1. Cable testers
 - 2. Test heads
 - 3. Adapter cords
 - 4. Latest version of software applicable for each tester planned for use.
- B. Provide written factory calibration recommendation letter and factory recommended field calibration intervals with bid.
- C. Provide signed manufacturer factory calibration certification for each copper and fiber tester owned at time of bid response as a submittal. Certification shall have serial number, date and version of software of each tester.
- D. For each tester planned for use on this project, provide a letter from the tester manufacturer indicating the correct interface adapters and test cords, and set-up procedures required to test perform the Category 6 permanent link and the Category 6, channel tests with the products identified for use on this project and the warranty requirements called for.
- E. Sample documentation from previous job for administration, test results and as-built drawings.
- F. At time of testing, provide a factory calibration certificate for each tester used and include these in each test report binder at the completion of the project.
- G. Test reports (submit prior to substantial completion punch list is performed)
- H. Two copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job. The database for the completed job shall be stored and delivered on CD including the software tools required to view, inspect, and print any selection of test reports.
- I. Technician certificates for successful completion of training for each of the field testers proposed to be used in this project.
- J. One copy of a binder and two copies on compact disks containing all digital photographs called for at the completion of the job.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 27 16 00